DOCUMENT RESUME

ED 244 054 CE 038 019

AUTHOR	Hughes, Larry R.
TITLE	Drafting.
INSTITUTION	Texas Univ., Austin. Extension Instruction and Materials Center.
SPONS AGENCY	Texas Education Agency, Austin. Dept. of Occupational Education and Technology.
PUB DATE	83
NOTE	104p.
AVAILABLE FROM	Extension Instruction and Materials Center, University of Texas, P.O. Box 7218, Austin, TX 78713-7218 (Stock No. IA 006 I--$12.50).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; Career Education; Classroom Techniques; Competence; Curriculum Development; *Drafting; *Educational Resources; Guidelines; Hand Tools; *Industrial Arts; *Job Skills; Job Training; Junior High Schools; Learning Activities; Learning Modules; Measurement Techniques; *Occupational Information; Orthographic Projection; *Teaching Methods; Technical Illustration; Trade and Industrial Education; Transparencies; Vocabulary; Vocational Education

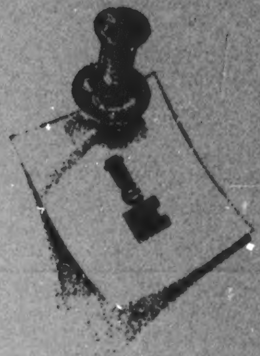
ABSTRACT

This guide to teaching drafting, one in a series of instructional materials for junior high industrial arts education, is designed to assist teachers as they plan and implement new courses of study and as they make revisions and improvements in existing courses in order to integrate classroom learning with real-life experiences. This drafting course is organized in seven units, each containing objectives, vocabulary, teaching aids (such as transparency masters), suggested references, a sentence outline of the material in the unit, suggestions for materials for students, student handouts, suggested student activities, and a multiple-choice test with answer key. The units cover the following topics: introduction to drafting, communicating ideas visually, measurement, drafting in industry, the drafting language, representing three-dimensional objects on paper, and occupational information about drafting careers. (KC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED244054

CE 038 619



DRAFTING

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

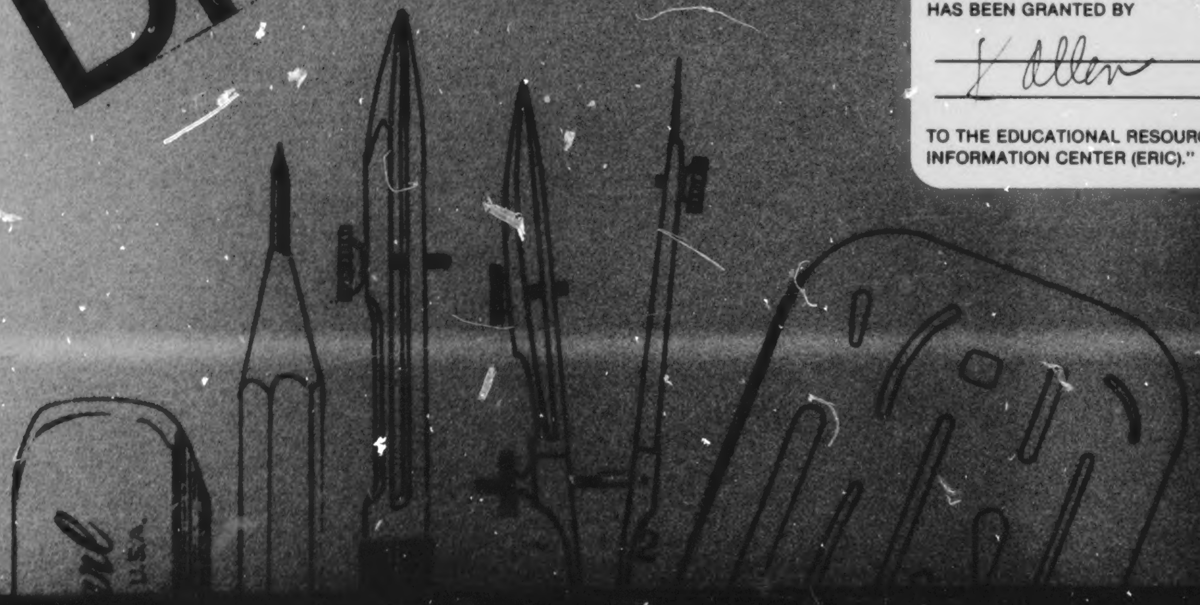
☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

V Allen

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."



Drafting

By

Larry R. Hughes, Ed.D.

Published by

Extension Instruction and Materials Center

Division of Continuing Education

The University of Texas at Austin

developed under contract with

Occupational Education and Technology

Texas Education Agency

Austin, Texas

1983

© 1983 by The University of Texas at Austin
All rights reserved. Published 1983
Printed in the United States of America

Brand names, company names, trademarks, or other identifying symbols appearing in the illustrations and/or text are used to clarify and identify and do not constitute a recommendation or endorsement by the author or the publisher.

Editor / Jane Herrick
Art Director / Ben E. Smith
Coordinator, Production / Barbara S. Lankes
Coordinator, Development / Jim Zukowski, Ed.D.
Proofreader / Kimberly Rust

Stock Number IA 006 I

Contents

Foreword / iv
Acknowledgments / iv
Notes to the Teacher / v
Competencies / vii

Unit I. Introduction to Drafting / *1*

- I. How do people communicate with one another?
- II. Discovering communication symbols

Unit 2. Communicating Ideas Visually / *5*

- I. Recording Ideas
- II. Everyone can use sketching skills
- III. Refining the idea
- IV. Communicating the refined idea

Unit 3. Measurement / *21*

- I. Need for standard measurement
- II. The English system of measurement
- III. The metric measurement system
- IV. Scaled measurements

Unit 4. Drafting in Industry / *39*

- I. Working as a drafter in industry
- II. Drafters use a variety of instruments, tools, and equipment

Unit 5. The Drafting Language /*57*

- I. The language structure of drafting
- II. Lines
- III. Lines and their meaning
- IV. Letters
- V. Symbols

Unit 6. Representing Three-Dimensional Objects on Paper / *73*

- I. Describing the shape of an object
- II. Multiview drawings
- III. Pictorials
- IV. Dimensioning drawings

Unit 7. Occupational Information About Drafting Careers / *97*

- I. Drafting as a career
- II. Occupations that utilize drafting skills and knowledge

Foreword

This publication is one of the new series of instructional materials for industrial arts education. It has been designed to assist teachers as they plan and implement new courses of study and as they make revisions and improvements in existing courses. This publication is an attempt to help industrial arts teachers create learning environments that respond to the needs of students growing up in a complex industrial-technical society. It provides a framework that enables teachers to integrate classroom learning with real life experiences of students.

Industrial arts is being challenged to expand and clarify its function. To meet this challenge, the industrial arts curriculum must provide opportunities for students to learn more about the technological realities in our society. This publication provides teachers with an instructional platform that focuses on industrial arts' commitment to establish its content base in the technologies.

Jack E. Robertson, Ph.D.
Director, Extension Instruction
and Materials Center

Acknowledgments

Extension Instruction and Materials Center acknowledges with grateful appreciation the contribution that industrial arts professionals have made to the visual communications curriculum material. Their suggestions, comments, and criticisms have strengthened this series. These individuals contributed to the review and evaluation process:

Bob Battle
Larry Stephenson
Ted Reyes
Charles Guthrie
Tim Runyon
David Butcher
Tommy Clark
Bud Bearce
John Peters
George Howle
Haley Haynes
Steve Stephens
Jim McGee
Ralph Kahla
Roel Arce
Ruben Laurel
Marvin Towse
Ellen Miller
Gilbert Espinosa
Frank Grijalva
Albert Sanchez
Thomas Bennett
Clifford Soderlind
Joe Lambert
Randy Locey
Cliff Martin
Ron Foy
James Moore
James Russell
Roque Segura
Phillip Martinez
Lloyd Gober
Herbert Friar
Chester Baker
Caryn Jannasch
Ethan Williams
Ronald Sorensen
George Norrell
Dave Odum
Harris Brothers
Mark Siracusa
John Wilhelm
Clarence Sapenter
Harry Duhart
Eva Torres
Richard Zanikos
Richard Schulze
Rachel Berkeley
Bill Hickman
Keith Rutledge
James Hamilton
Dan Strouf
Edward Sofin
Bill Cullers
Joe Starke

Special recognition and appreciation is extended to the Center's Industrial Arts Advisory Committee for its leadership, guidance, encouragement, and recommendations during the development of this material:

Benton Brockette, Chairman
Dr. Daniel L. Householder
Dr. W. A. Mayfield
Thomas San Miguel
Ralph Schultz
Jim Payne
Daniel Jaime
Kitt Sukup

This Center is deeply indebted to Dr. Gene Martin for his professional management and leadership as director of the pilot program. We also thank Cam O'Keefe for her valuable assistance in the pilot program.

The industrial arts professionals who piloted the visual communications curriculum material have made it possible to enhance the education of our youth. We owe a debt of gratitude to these individuals:

Robert Fair
George Hyland
Reavis Wortham
Dean Heller
Donald Shanklin
Jerry Martin
Chuck Bridge
Randy Locey
Timothy Smith
Lloyd Gober
James Hunt
R. Mike Mueller
Herbert Friar

The Center gratefully acknowledges the cooperation, support, and suggestions that the following vocational directors, industrial arts supervisors, and their local districts provided to make this material a reality:

Robert Hafernik, San Antonio ISD
Dr. Charles Thompson, Midland ISD
Joe Pat Attaway, Duncanville ISD
Cletus G. Michel, El Paso ISD
Richard Perez, El Paso ISD
Hayden McDaniel, Carrollton-Farmers Branch ISD
Wesley Van Matre, Pharr-San Juan-Alamo ISD
Sandra Marvel, Wichita Falls ISD
Mike Pickett, Wichita Falls ISD
Louis Igo, Austin ISD
Ron Foy, Austin ISD
Leonard Theilen, McAllen ISD
Nolan Alders, Nacogdoches ISD
Willie Spencer, Houston ISD
Benton Brockette, Beaumont ISD
Kenneth D. Abendroth, Dickinson ISD
Dean Bigham, Amarillo ISD
Jimmie Goodman, Amarillo ISD
Billy R. Jones, Abilene ISD
Cecil L. Allen, Abilene ISD

A special thanks is due to Neil Ballard of the Texas Education Agency for his leadership, patience, support, and encouragement throughout the development of the visual communications curriculum material.

Larry R. Hughes
Industrial Arts Curriculum Specialist

Notes to the Teacher

Using the Curriculum Material

Intended Audience. The material in this curriculum package is designed for use by junior high/middle school industrial arts teachers in exploratory/introductory programs.

Length of Time for the Material. Each of the four topics of study (introduction to drafting, introduction to graphic arts, introduction to photography, and introduction to computer applications) has been developed to provide enough material for eighteen weeks of study. Individuals who teach six-, nine-, or twelve-week classes can use selected parts of this curriculum material as the substance of their classes.

Emphasis of the Material. Keep in mind that these curriculum materials are exploratory in nature. The emphasis is on exposing students to a wide range of experiences within each topic of study rather than on the development of technical expertise in one area.

Benefits for Teachers and Students. These materials are designed to assist industrial arts teachers in the classroom as they reinforce and enhance students' skills in reading, mathematics, communication, problem solving, and social interaction. In addition, teachers who use this curriculum material will be able to help their students gain an understanding of and an appreciation for management and work skills needed by individuals in the world of work. The broad exposure students receive in each topic of study will assist them in making meaningful career choices.

Flexibility of the Materials. This curriculum material, like any other material, cannot encompass all situations. Therefore, teachers should feel free to supplement this material with other ideas, information, or activities needed in their particular programs.

This material can be used in a number of different ways by industrial arts teachers. Some teachers may desire to use it as the starting point, a foundation on which to build their own courses of study. Other teachers may prefer to teach the material as it is and add to it as they feel the need. Still other teachers may pick and choose only selected parts of this curriculum for use in their classes.

Teachers may also need to make substitutions in the curriculum depending on the equipment or references available. Other circumstances may also require teachers to make curriculum substitutions. The flexibility of this material enables teachers to use it in various ways and under various conditions. This curriculum provides teachers with an alternative in course design.

Competencies. Competencies have been identified for the topic of study. As used in this material, competencies represent skills, knowledge, or attitudes that imply the ability or intelligence to accomplish a task or job. They represent the instructional intent and are stated as specific goals to be achieved. Competencies assist teachers and students in clearly formulating a purpose for learning.

Organization of the Curriculum Material

The material in each topic of study is organized into instructional units. The framework used to develop each unit consists of a number of components. These components focus on (1) outcomes, (2) materials, (3) content, (4) activities, and (5) evaluation. The components are further divided and standardized in each topic of study. An explanation of each part in the instructional unit follows.

Objectives. Objectives have been identified for each instructional unit. The objectives reflect the kind of performance necessary to successfully complete a task or job. These objectives enable a student to attain the stated competencies. Furthermore, each unit's objectives are reflected in the content, student activities, and test for that unit. Objectives help the teacher and student to focus on the important concerns to be learned in each unit. Teachers may want to duplicate the competencies and objectives and give them as handouts to the students.

Key Words: Vocabulary. New words or terms are listed to enable you to help students develop their vocabulary. Some words or terms may be listed in several units because they are used throughout a topic of study. The repetition helps reinforce vocabulary building. You will also find that each of the key words or terms has been **boldfaced** in the sentence outline. A student vocabulary worksheet has been included with each unit.

Teaching Aids. The materials, equipment, and supplies identified will enable the teacher to plan and organize instruction better. Teachers need to review this list of teaching aids before the day of instruction since some substitutions in equipment may be needed under certain conditions. A test key has been included to help the teacher in correcting the unit test.

Each transparency in the unit is also listed and briefly described. Transparency masters are provided at the end of each unit. The transparencies are keyed to a point in the sentence outline where their use is considered most appropriate. In addition to being used as transparencies, the masters may be duplicated and used as student handouts if the teacher so desires. Teachers may design or develop other transparency material that they feel enhances their instruction.

Suggested References. Many of the publications listed are available from textbook publishers. However, the reading level of these textbooks is often above junior high/ middle school grade level. The materials listed in this section are suggested for use by teachers as a way to supplement their knowledge in the subject area. Teachers can review these references and use selected materials as supplements to their lectures and demonstrations when appropriate. Some of the sources suggested offer free or inexpensive materials that teachers may use with their students.

Sentence Outline. The information presented in this section represents the conceptual focus for the unit. The ideas and concepts are presented in a sentence outline, as a guide from which to teach. The outline should serve as a reference from which teachers can provide instruction. The intent was not to needlessly duplicate material that is readily available to teachers. Rather, the intent was to provide teachers with basic ideas and information that may be less accessible. The suggested references and other resources can be used by teachers to build a knowledge base from which they can synthesize relevant concepts and information. Suggested references can be used to supplement, expand, and clarify learning activities and instruction.

Materials for Students. Suggestions to teachers regarding student materials may also be listed here. Student handout materials, such as worksheets, charts, graphs, and puzzles, are provided at the end of each unit when appropriate. These student handouts immediately follow the suggested student activities section. Handout materials may be reproduced in quantities and given to students.

Suggested Student Activities. The suggested activities are designed to reinforce and provide real applications of the concepts and content within each unit. These activities have been designed to use existing facilities and equipment as much as possible. Another consideration was the cost factor. Suggested activities are designed to require the minimum cost. Each teacher should, therefore, examine the activities and select those which are appropriate for his or her students. Teachers can change or modify the suggested activities if equipment, materials, and funds are not available. Teachers need to be selective in the activities they use since some activities take longer than others. Some are designed for group activity while others are for individual work. The teacher's content emphasis must also be considered. Each of the activities has been designed to reinforce and enhance basic skills that students need in everyday life.

Tests. Each unit has a multiple-choice test to assist teachers in evaluating student achievement. Multiple-choice tests provide certain advantages for teachers in evaluating the teaching-learning process. They do not capitalize on chance answers to the extent that true-false tests do. Careful development of test answers will help teachers evaluate a student's comprehension of important concepts. This also provides teachers with an easy way to assess the effectiveness of their instruction through item analysis.

Written tests are only one method of assessing learning. Teachers will also need to evaluate a student on actual performance in each activity, on abilities, and on general progress towards reaching objectives. Each teacher should develop an evaluation system that provides the most accurate assessment of a student's progress.

Teachers may prefer to develop their own test instruments. However, their test items should focus on the objectives and course content. The test for each instructional unit in this curriculum material does focus on the objectives stated at the beginning of each unit and on the unit content. A test key is also provided in the teaching aids section of each unit for the teacher's use in correcting tests.

Competencies

- Acquire an awareness of the ways drafting is used by individuals each day.
- Become familiar with several ways in which human beings communicate their ideas through visual means.
- Acquire an understanding of the usefulness of sketching as a way to communicate ideas visually.
- Develop an awareness of the tools, instruments, and equipment that drafters use in industry.
- Become familiar with some of the work drafters do as a part of their jobs in industry.
- Become aware of drafting as a language and the use of this language in everyday life.
- Acquire an understanding of the importance of a standard unit of measurement in technological developments.
- Develop an understanding of and a degree of skill in using both the English and the metric system.
- Acquire an awareness of the ways multiview and pictorial drawings are used by industry.
- Become familiar with occupations that are available in drafting.
- Become familiar with occupations that use the skills and knowledge of drafting.

1 Introduction to Drafting

INTRODUCTION

It is important for you to read "Notes to the Teacher" before you begin teaching this topic of study.

This unit is designed to get students involved in activities that relate to drafting and its use in the world around us. After students have completed the introductory activities, they can move to a study of drafting and more related activities. The activities suggested in this unit are not all-encompassing. Rather, they are intended to provide teachers with ideas they can use to get students involved. There are many other activities that will develop student interest and involvement, and these may also be used. Remember this is an exploratory curriculum. Each subsequent unit also provides suggested student activities.

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. identify several ways that drafting is used in the world in which we live;
2. draw simple layouts of an area to show the location of objects, buildings, or other features;
3. become familiar with charts that show comparisons of data; and
4. make a simple map that provides directions to a specific point.

TEACHING AIDS

- Overhead projector
- Grease pencils
- Charts that show comparisons or present data
- Maps of states (Maps can sometimes be obtained from departments of tourism and state highway departments.)
- Maze puzzles, for use as examples
- Newspapers
- Blueprints
- Schematics
- Transparencies: You will find transparency masters D1-1 and D1-2 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to the students while they are studying this unit. An explanation of each transparency follows.

D1-1: Bar Graph; illustrates one use of this type of graph.
D1-2: Line Chart; illustrates one use of this type of chart.

SUGGESTED REFERENCES

The references listed here represent only a few of those available. School Shop, Industrial Education, and Man/Society/Technology are a few of the professional magazines that provide information for drafting teachers.

Brown, W.C. Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1975.

Groneman, C.H., and Grannis, G.E. Exploring the Industries. Albany, N.Y.: Delmar Publishers, 1981.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982.

Wallach, P.I. The Basic Book of Drafting. Chicago: American Technical Society, 1979.

SENTENCE OUTLINE

I. How do people communicate with one another?
   A. One way to communicate is through visual means. Each person sees objects, people, colors, designs, printed matter, natural things, and anything else within the field of vision.
   B. Each thing we see has some meaning. Much of what we see is represented in symbols. Words, letters, numbers, pictures, and charts are symbols that give us information. (See Transparencies D1-1 and D1-2.)

II. Discovering communication symbols
   A. Look around the classroom and observe the symbols we use for communication. There are maps, bulletin boards, textbooks, safety posters, exit signs, room numbers, and many other symbols that we encounter daily.
   B. This class will help you become aware of the ways in which visual communications are used. It will also help you to communicate your ideas better

through the use of a variety of materials. You should also be able to understand visual communications better.

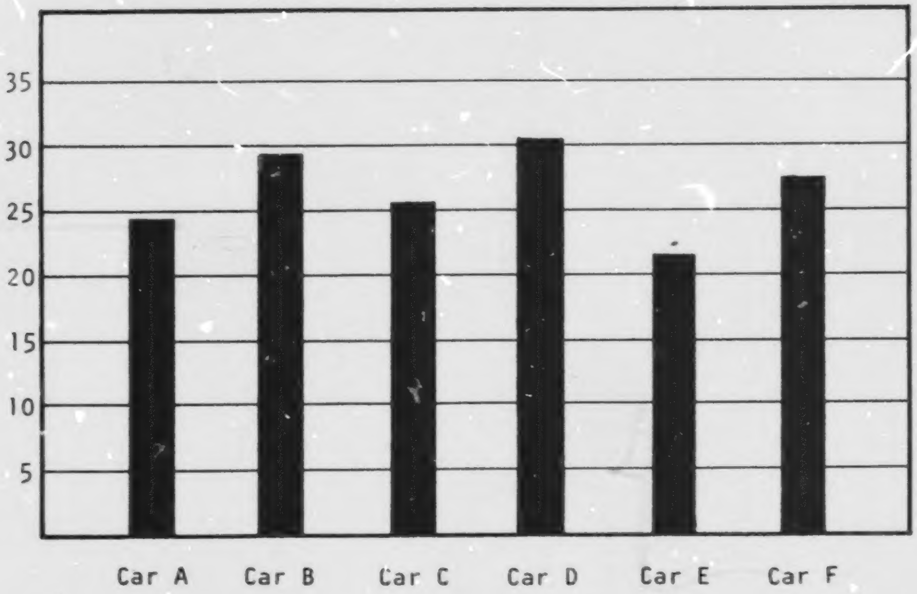
MATERIALS FOR STUDENTS

- Rulers
- Straight edges
- 8-1/2 x 11 in. paper
- 50 ft. tape for outside measuring
- Pencils

SUGGESTED STUDENT ACTIVITIES

1. Have each student develop a maze puzzle that presents a challenge for others to solve. Each puzzle must fill an entire 8-1/2 x 11 in. sheet of paper. There must be one entrance or exit located at the center of each side of the paper. Centering each entrance or exit allows students to join their puzzles along the sides and make more difficult mazes.
2. An alternate activity to No. 1 above is to have each student develop a maze puzzle of his or her own design. Then students could swap puzzles to see who can solve their puzzles the fastest.
3. Have students draw a layout of the school grounds. The drawings should show the outline of the building; the location of the building; the locations of playground equipment, if any; the location of parking lots; fences; and streets bordering the school grounds. Students may need to measure the outside of the building to get an idea of its size in relation to the school grounds.
4. Have students draw a map that shows how to get from school to their homes. Each map should show some landmarks along the route so that an individual who has never been in that part of town could find the house.
5. Have students draw a layout of the classroom or another classroom. The drawings should show desks, tables, chairs, storage cabinets, storage rooms, work areas, tools, equipment, aisles, exits, and any other pertinent information.

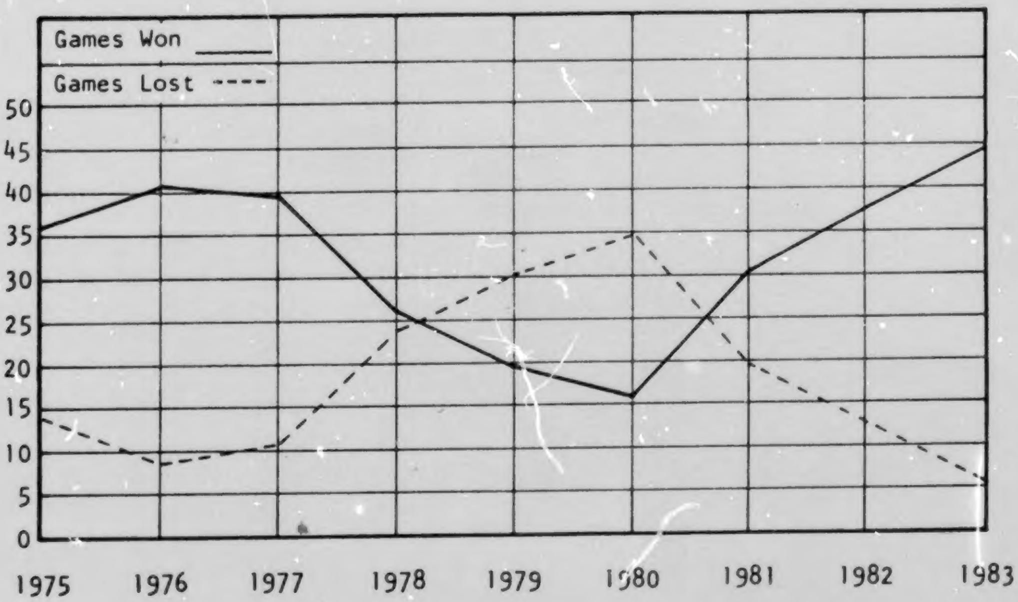
BAR GRAPH



AVERAGE MILES PER GALLON - ECONOMY CAR TEST

D1-1

LINE CHART



MITSU TURTLES BASEBALL RECORD

D1-2

2 Communicating Ideas Visually

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. identify several ways human beings communicate through visual means;
2. explain what sketching is;
3. describe how drawings are used in industry; and
4. make sketches that present data, give information, or provide directions.

KEY WORDS: VOCABULARY

The following words may be new to the student studying drafting. Teachers should help students understand these words as they are used in this topic of study.

written communication
magnetic tape
computers
artists
sketches
sculptors
drafters
architect
technical drawings

TEACHING AIDS

- Overhead projector
- Grease pencils
- Chalk
- Chalkboard
- Pictures or photographs, magazines
- Film, videotape, or cassette
- Theme outlines
- Novels, short stories
- Textbook
- Mechanical Drawing Film Loops
  McGraw-Hill Book Company
  8301 Ambassador Row
  Dallas, Texas 75247
- Milliken Transparency/Duplicating Books. TDT11 Lettering, Scales, and Sketching. This book can usually be purchased through school supply businesses listed in the Yellow Pages.
- Test key: 1-A, 2-C, 3-B, 4-D, 5-B, 6-B
- Transparencies: You will find transparency masters D2-1 through D2-4 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to students while they are studying different aspects of this unit. An explanation of each transparency follows.

D2-1: Some Ways People Communicate Ideas Visually; outlines five ways of communicating visually.
D2-2: Technical Drawing; illustrates how these drawings can be used to communicate ideas easily.
D2-3: Communicating with Sketches; illustrates how a sketch can be used to present an idea.
D2-4: Refining Ideas Through Sketches; illustrates how sketches can be used to refine an idea before it is drawn in detail.

SUGGESTED REFERENCES

Brown, W.C. Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1975.

Feirer, J.L., and Lindbeck, J.R. Basic Drafting. Peoria, Ill.: Charles A. Bennett Company, 1978. (Student workbook available.)

Feirer, J.L., and Lindbeck, J.R. Drawing and Planning for Industrial Arts. Peoria, Ill.: Charles A. Bennett Company, 1975.

Groneman, C.H., and Feirer, J.L. General Industrial Education. New York: McGraw-Hill Book Company, 1979.

Groneman, C.H., and Grannis, G.E. Exploring the Industries. Albany, N.Y.: Delmar Publishers, 1981.

Miller, W.R., and Ross, S. Drafting. Bloomington, Ill.: McKnight Publishing Company, 1978.

Spence, W.P. Basic Industrial Drafting. Peoria, Ill.: Charles A. Bennett Company, 1979.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982. (Student workbook available.)

Wallach, P.I. The Basic Book of Drafting. Chicago: American Technical Society, 1979.

SENTENCE OUTLINE

I. Recording ideas (Use Transparency D2-1)
   A. Human beings record their ideas in many ways. They use a written language to communicate their ideas to others. They use electronic devices to record ideas and messages for others. Some individuals also communicate their ideas through paintings, pictures,

and drawings.

B. Written language
   1. Almost all human beings use some form of **written communication** to record their ideas. The textbooks in the classroom are written in the main languages of the United States. Individuals in business and industry correspond with employees in other companies by writing letters or filling out forms.
   2. Newspapers and magazines use the written language to record descriptions of events of interest to their readers.
   3. Students use written language when they take notes, write papers, or take tests. Sometimes their ideas are not accurately represented by what they write. Other individuals may misinterpret what has been written because of the words or structure used.
   4. One important factor in written communication is that each person must be able to read and understand the idea that is being communicated. Because words have several meanings, the idea is not always clearly understood by everyone.

C. Electronic devices
   1. **Magnetic tape**, such as that used in computers, cassette recorders, and video recorders, is used to record and communicate information. Teletype machines are used to prepare a special paper tape that can be used to store information or to communicate with other people or to operate machines.
   2. Some **computers** use special cards that have punched holes that record information. These cards can be used over and over again when the information is needed. Some checks and bills have these holes so that they can be processed by computers when returned to the company that issued the check or bill.
   3. Many credit cards have magnetic tape on the back that contains information about the user, account number, and identification number. This magnetic tape can be read by a computer and by persons who operate the computer.
   4. Magnetic tapes and discs are used in industry to record information. These tapes and discs can be used with a computer to assist employees in doing their jobs. Some grocery and department stores use magnetic tapes and discs to record inventory levels and as a source for printouts containing sales information and stock records. Some word processors use cassette tapes to record information that the clerical staff can analyze on video screens. The information on the tape can be updated or changed easily.
   5. Movies are recorded on film, videotape, and video discs. These recordings can be used often and will remain permanent records of the recorded communication.
   6. Some schools use films, videotapes, and video discs to provide additional information to their students in class. The films or videotapes can be replayed by the students if they need further clarification on some point or idea.

D. Painting, pictures, and sculptures
   1. **Artists** use paint to create a picture that is used to communicate an idea or theme to an audience. They may use charcoal, chalk, watercolors, oil paint, or acrylic paints to provide colors or contrasts.
   2. A painting represents an artist's feelings and emotions at the time he or she created the artwork. Each individual who views the painting can interpret the work in a number of ways as he or she tries to understand the artist's message.
   3. **Photographers** take pictures to record an image that can be used to present an idea or preserve a particular moment.
   4. By selecting the correct scene, a photographer can present an idea through a photograph. Such photographs can be seen in magazines, newspapers, and art galleries.
   5. Advertising agencies use photographs to focus attention upon the item being offered for sale. News-

papers record newsworthy events on film and use pictures to clarify a story or an article.

6. Individuals record a part of their history in photographs. Inexpensive cameras allow people to take pictures of family members, vacations, family reunions, or other significant events in the lives of family members or friends.
7. **Sculptors** create records of people and events through the use of many materials. These artists create statues, busts, and visual images of people. They also create modern artwork that represents certain events or conditions in history. Some create works that reflect their feelings toward events or conditions in society.
8. Sculptors have spent many years to create memorials, such as those at Mt. Rushmore and Stone Mountain. Both provide records of American history.

E. Technical drawings (Use Trans. D2-2)

1. Manufacturing and construction industries use detailed drawings to guide workers as they produce products or build structures.
2. **Drafters** record the exact specifications on paper, plastic film, or by computer. These drawings enable other workers to see what each part of the product or structure looks like in the developmental stage.
3. A written description would be too costly to develop and extremely time-consuming to interpret. It might not provide an accurate description, and it surely cannot be used as easily and effectively by industry employees in their jobs. Pictures cannot be taken of the product or structure since they do not exist except in the minds of people and, in part, on drawings.
4. When an **architect** draws plans for a building or house, he or she must draw detailed views of the structure so that it can be built correctly. Contractors must know how the foundation is to be constructed, how the plumbing and electrical systems are to be installed, how the walls and roof supports are to be built, and how the structure is located on the site. The architect must also provide other information that will also help the contractor to build the structure correctly.
5. **Technical drawings** are used to record all the details necessary to make the product or to build the structure. A drawing is an efficient way to communicate the information from one person to another. Each person must be familiar with the language used in drafting if the communication process is to be effective. An example of a technical drawing that you may be familiar with is that enclosed with a model kit.
6. One drawing can show more details than several pages of written instructions. It is a faster and easier way to communicate ideas from one person to another more accurately.

F. Sketching (Use Trans. D2-3)

1. **Sketches** are drawings that are made without the use of instruments. Sketching is a fast, efficient, and easy way to record ideas. Initial sketches are not drawn to any particular size. Their purpose is to record an idea that comes to mind.
2. A quick sketch does not take a lot of time, and it gives the person the freedom to generate other ideas. The initial ideas do not need to be drawn in detail since they will need to be refined anyway.
3. A sketch can be used to record an idea and to communicate that idea to others easily. Individuals in industry use sketching as a way to generate new product ideas and stimulate creative thinking. Even though most sketches will not be used, some will be combined, refined, improved, and may eventually be drawn to show details. Only a small percentage of the ideas will ever be fully developed into finished products.

II. Everyone can use sketching skills

A. You have probably already learned

how to make some sketches. Look on your notebooks and loose-leaf paper.

B. Sketches are drawings that are made without the use of drawing instruments. They are done freehand. Sketches are made by drawing a series of short lines, rather than one continuous line, to form the shape of the object. The short lines are usually done lightly and then darkened and connected to form the finished sketch.

C. In industry, engineers, technicians, and drafters use sketches to communicate their ideas for new products, solutions to problems, or changes to existing products. Sketches are also used in several other ways, such as designing new layouts for existing facilities. Since sketches are made very quickly, they can assist individuals in the planning stages as they assess the feasibility of new ideas.

D. At some point in your life, you will probably need to make several sketches of an item that you wish to make. Sketches will enable you to see your design on paper. They will assist you in making changes in your design before you begin making it.

E. In the initial efforts to record ideas through sketches, you should not be concerned with the size of each part. The main emphasis at first is recording the idea before you forget it. You will have plenty of time later to think about the various sizes as you refine the idea.

III. Refining the idea (Use Trans. D2-4)

A. Usually, anyone's initial ideas can stand some improvement. This improvement can come as the individual gives further thought to the idea or, perhaps, from a friend or colleague who has a chance to examine the idea and offer suggestions.

B. Writers refine their outlines before they begin to write. They also refine their stories or articles several times before they are printed.

C. Artists often change their creations several times from the initial idea to the finished work. They refine their ideas to make them clearer and to represent exactly what they intend them to represent.

D. Designers, engineers, technicians, and drafters must also refine their ideas to improve on them. This refinement process may take several months, with input from many individuals. Do not be afraid to change a design, especially when a part or all of it does not work well.

E. The advantages and disadvantages of each idea should be analyzed before rejecting or accepting it for further analysis. Each idea should be considered in terms of cost, utility, appearance, and complexity for the user.

IV. Communicating the refined idea

A. When the initial idea has been refined, it must communicated to others so they will understand what the final product will look like.

B. A final sketch should show the parts of the object in proportion to one another. For example, a one-inch wheel should not appear twice as big as a three-inch wheel. If each part is not shown in proportion to the other parts, the sketch will be deceiving. Individuals may be led to reject the idea because of poor communication.

MATERIALS FOR STUDENTS

- Paper for sketching
- Pencils
- Student Worksheets 1 and 2

SUGGESTED STUDENT ACTIVITIES

1. Have the students use the written language to describe the front of their homes. The written description should provide sufficient details to that a person who has never seen it before can create a visual image of it. After students have completed the written description, have each one make a sketch of the front of his or her home.

   Divide the class into groups of three or four students each. Have the students compare both methods of communication. They need to examine the appropriateness of both written communication and sketching as ways of communicating. Have them make a list that shows when written communication would be appropriate and when sketching would be appropriate.
2. Have the students use the written lan-

guage to provide directions from one location to another. You might want them to use the school and their home as the two locations. After they have completed the written directions, have them draw a map that shows the same route. Compare the two methods of communicating.

3. Have the students write the instructions for evacuating their school building in the event of a fire. After they have written the instructions, have them sketch a floor plan that shows the fire evacuation route. They will need to examine both the written instructions and the sketch and decide which would be most useful in an emergency. They should be able to identify several advantages to using pictorial representations to communicate information. Where would this type of visual communication be useful?
4. Have each student sketch a fire evacuation plan for his or her home. Students may want to identify what to do after they get out of the house, i.e, all family members to meet so everyone can be accounted for.
5. Have students sketch several project ideas that they would like to make. They can use any kind of material they wish. After the initial ideas are sketched, have them select one idea, refine it, and make a finished sketch. The sketch should be in proportion and show approximate sizes.
6. Use Student Worksheets 1 and 2. Have each student sketch the objects on the worksheets. Students should enlarge their sketches so the objects cannot be traced over. Each sketch should be made so the object remains proportional in height, width, and depth. It may be more convenient, in some cases, to use the worksheet as a transparency and have the students make their sketches from a view projected by the overhead projector.
7. Have students participate in this verbal communication activity to help them understand the need for visual communication. Each student in class should participate. Whisper the following statement to one student: "Benjamin Hastings, a 14-year-old boy from North Meadows, Virginia, has just moved into the old brown and beige house at 1734 Walnut Avenue."

   The first student should whisper this statement to the next student and continue the process until all students have passed the statement on. The last student should be asked to repeat what he or she was told to the class.

   Two rules should govern this activity: (1) The statement must be whispered so that students nearby cannot hear it, and (2) it can only be whispered once to a student before he or she must pass it on.

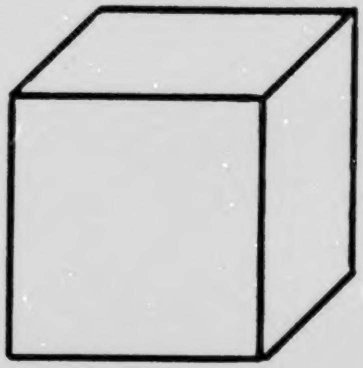
   You may choose to use another statement if it is more appropriate. After the activity, lead the class in a discussion of the problems inherent in verbal communication and the need for visual communication.

Vocabulary Worksheet

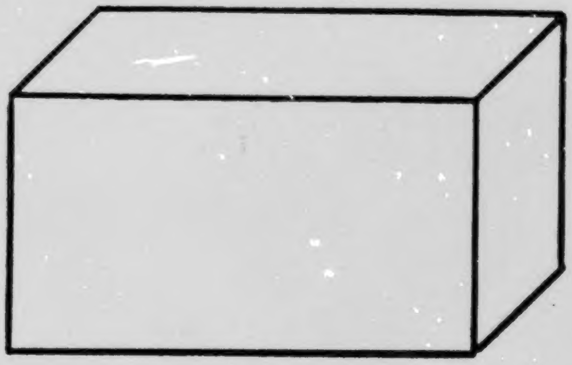
1. written communication
2. magnetic tape
3. computers
4. artists
5. sketches
6. sculptors
7. drafters
8. architect
9. technical drawings

STUDENT WORKSHEET 1

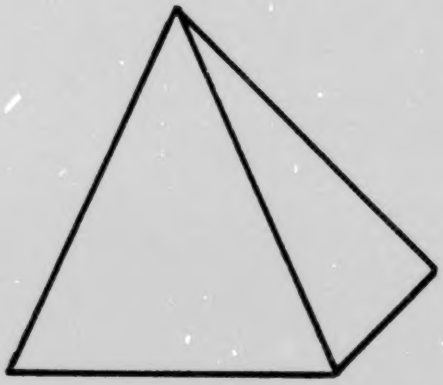
SKETCH EACH OF THE OBJECTS SHOWN BELOW. MAKE YOUR SKETCHES APPROXIMATELY TWICE THE SIZE SHOWN.



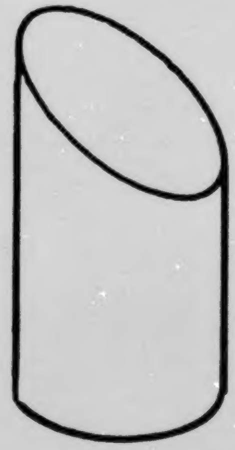
SQUARE



RECTANGLE



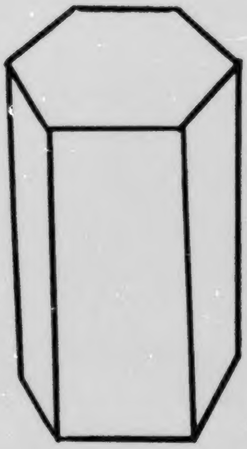
PYRAMID



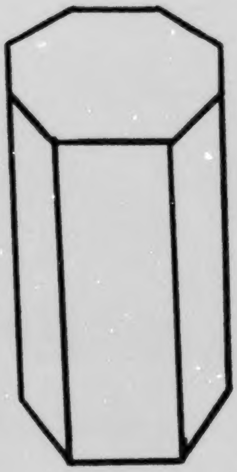
CYLINDER

STUDENT WORKSHEET 2

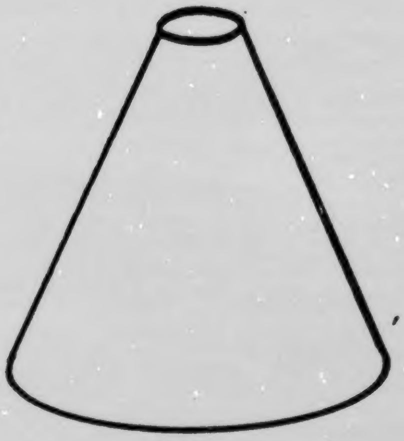
SKETCH EACH OF THE OBJECTS SHOWN BELOW. MAKE YOUR SKETCHES APPROXIMATELY TWICE THE SIZE SHOWN.



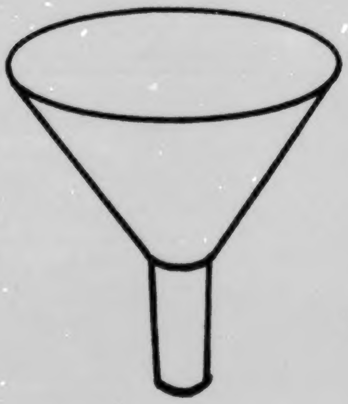
HEXAGON



OCTAGON



CONE



FUNNEL

TEST

Unit 2: Communicating Ideas Visually

Directions: Read each statement carefully. Select the one word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank.

Example: _C_ 21. The class you are now attending is—

A. American Government
B. Language Arts
C. Industrial Arts
D. General Science

___ 1. Human beings communicate their ideas visually through—

A. written language, pictures, and drawings
B. written language, spoken language, photographs
C. spoken language, photographs, musical records
D. written language, pictures, musical records

___ 2. Newspapers and magazines communicate ideas through—

A. sound recording and photographs
B. film and photographs
C. pictures and written language
D. film and written language

___ 3. Ideas communicated through the written language are not always clearly understood because many words—

A. are difficult to pronounce
B. have several meanings
C. have several syllables
D. have no definition

___ 4. Because written descriptions are too costly and inefficient, industry communicates many technical details of products through—

A. sound recordings
B. typed instructions
C. paintings
D. drawings

___ 5. A more efficient, accurate way to communicate detailed information from one person to another is through—

A. typed instructions
B. drawings
C. verbal instructions
D. printed information

___ 6. Drawings that are made without the use of instruments are—

A. technical drawings
B. sketches
C. finished drawings
D. prints

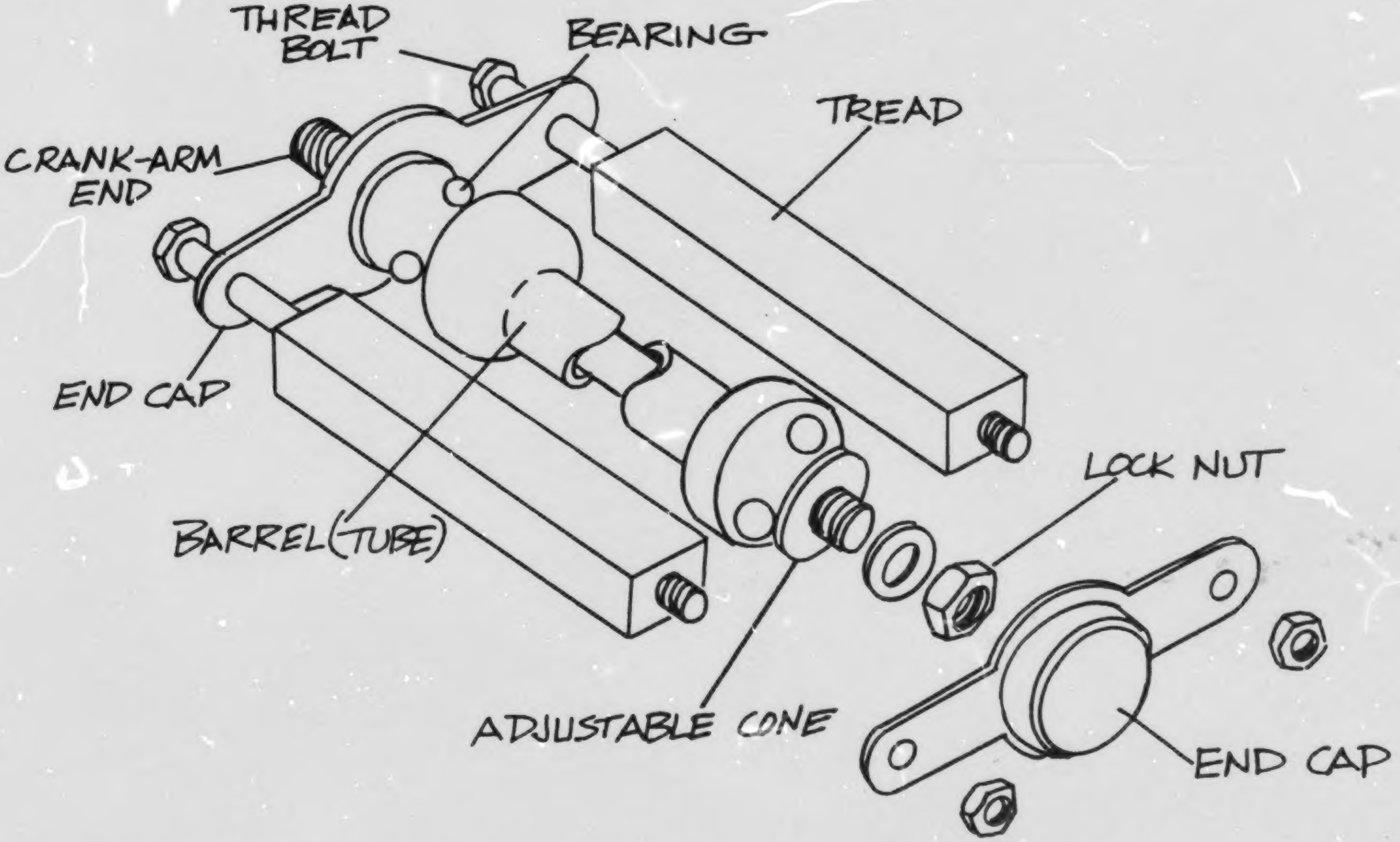
SOME WAYS PEOPLE COMMUNICATE IDEAS VISUALLY

1. WRITTEN LANGUAGE
2. VIDEOTAPE, FILM, VIDEO DISC
3. PAINTINGS, PHOTOGRAPHS, SCULPTURES
4. TECHNICAL DRAWINGS
5. SKETCHES

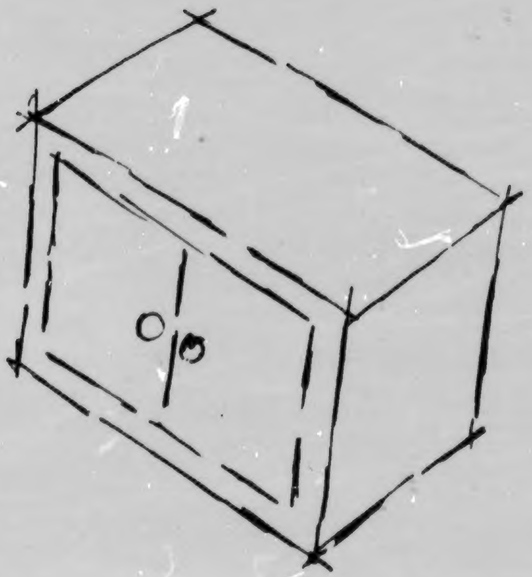
18

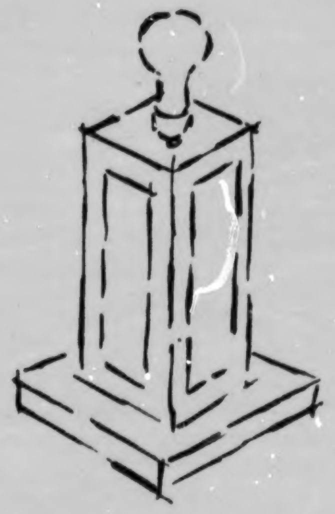
D 2-2

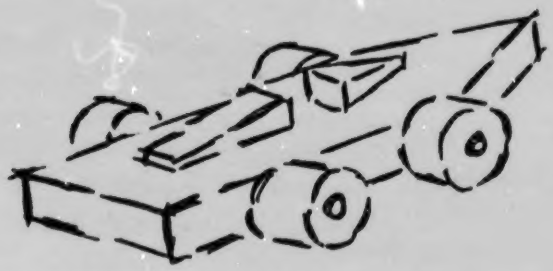
(TECHNICAL DRAWING)
BICYCLE PEDAL ASSEMBLY


THREAD BOLT
BEARING
TREAD
CRANK-ARM END
END CAP
BARREL (TUBE)
LOCK NUT
ADJUSTABLE CONE
END CAP

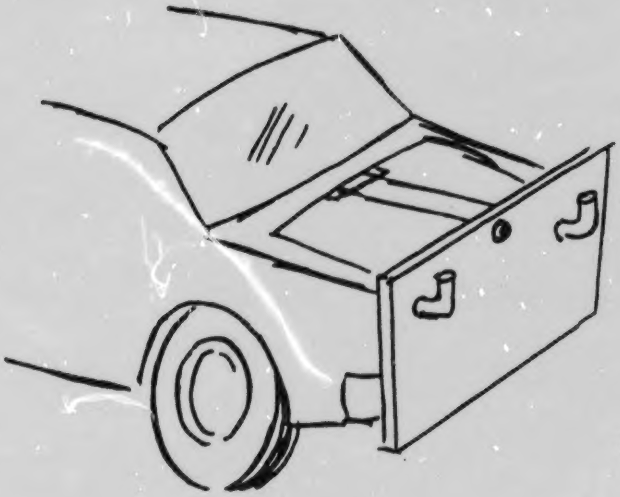
COMMUNICATING WITH SKETCHES

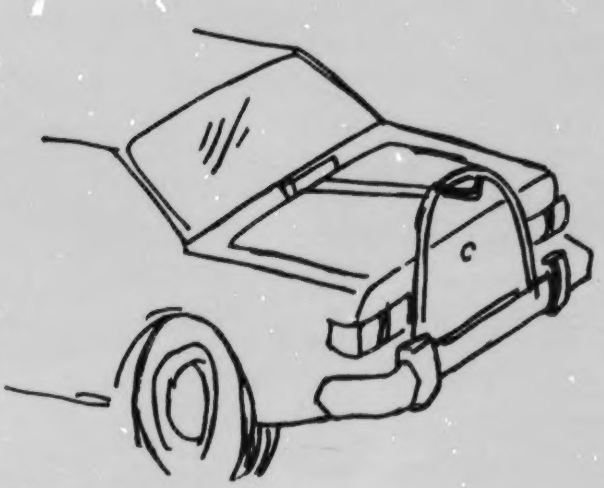


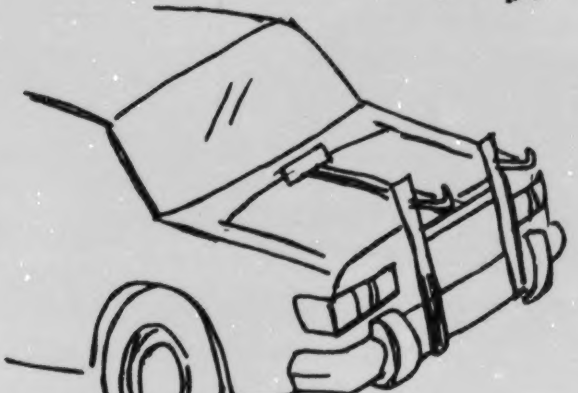




REFINING IDEAS THROUGH SKETCHES
(BICYCLE CARRIER)







3 Measurement

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. develop skills in measuring accurately to one-sixteenth inch;
2. explain the two primary measurement systems used in the world today;
3. explain the need for standard units of measurement within and between technological societies;
4. develop skills in measuring accurately with the metric ruler; and
5. explain the use of scaled measurements in drafting.

KEY WORDS: VOCABULARY

The following words may be new to students studying drafting. Teachers should help students understand these words as they are used in this topic of study.

standard measurements
English system
metric system
ruler
inch
meter
centimeter
scale
half-inch
one-fourth inch
one-eighth inch
one-sixteenth inch
fraction
millimeter
dimensions

TEACHING AIDS

- Chalkboard, chalk, erasers
- Overhead projector and pointer
- Scales and rulers
- Test Key: 1-B, 2-D, 3-C, 4-C, 5-B, 6-D, 7-C, 8-B, 9-B
- See Answer Key to student worksheets
- Transparencies: You will find transparency masters D3-1 through D3-4 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to the students while they are studying different aspects of this unit. An explanation of each transparency follows.

D3-1: Some Early Standards of Measurement; illustrates some body parts that are used for measurement.

D3-2: Standard Ruler Measurements in Sixteenths of an Inch; shows part of a ruler divided into sixteenths of an inch and an enlarged inch divided into sixteen parts with each division labeled in sixteenths.

D3-3: Standard Ruler Measurements in the Metric System; shows two rulers, one divided into centimeters and one divided into millimeters.

D3-4: Scales Used by Drafters; illustrates two scales used by drafters in their work. Shown are the architect's and engineer's scales.

SUGGESTED REFERENCES

Brown, W.C. Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1975.

Brown, W.C. Drafting for Industry. South Holland, Ill.: The Goodheart-Willcox Company, 1981.

Feirer, J.L., and Lindbeck, J.R. Basic Drafting. Peoria, Ill.: Charles A. Bennett Company, 1978. (Student workbook available.)

Feirer, J.L., and Lindbeck, J.R. Drawing and Planning for Industrial Arts. Peoria, Ill.: Charles A. Bennett Company, 1975.

Groneman, C.H., and Grannis, G.E. Exploring the Industries. Albany, N.Y.: Delmar Publishers, 1981.

Milliken Transparency/Duplicating Books. TDT11 Lettering, Scales, and Sketching. These books can usually be purchased through school supply businesses listed in the Yellow Pages.

Spence, W.P. Basic Industrial Drafting. Peoria, Ill.: Charles A. Bennett Company, 1979.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982. (Student workbook available.)

Walker, J.R. Exploring Metric Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1980. (Student workbook available.)

Wallach, P.I. The Basic Book of Drafting. Chicago: American Technical Society, 1979.

SENTENCE OUTLINE

I. Need for standard measurement (Use

Transparency D3-1)

A. When people buy, sell, or swap goods or property, they use a standard measure which allows them to compare equivalent values and amounts.

B. Before a standard measure was established, people had to use hand widths, arm lengths, and a person's foot as measuring devices. Since each of these vary in size, the quantity purchased or sold also varied.

C. As people in different geographical areas began to trade with one another, the need for **standard measurements** became more important.

D. Today there are two standard systems of measurement used in the world. They are the **English system,** which is used primarily by the United States, and the **metric system,** which is used by most other countries.

E. The United States is changing to the metric system very slowly. In order to compete with other countries in trading markets, it is necessary to produce goods they can readily use.

F. Standard measurements also enable manufacturers to mass-produce items. For example, you can go to any hardware store and purchase a No. 10 flathead wood screw, and it will be the same regardless of where it is purchased. The same is true if you want to buy a 1/4-20 NC hex head bolt. You can buy these from any supplier, and they will be the same.

G. Standard measurements enable manufacturers to produce parts that are interchangeable. This, in turn, permits trade with a wider variety of customers.

H. A customer in Germany can order parts from manufacturers in the United States, France, Japan, or any other country and receive a part that fits because it was made using the same standard system of measurement.

I. How could you make any comparison between canned soft drinks if each manufacturer used a different standard of measure and charged a different price for the product? It would be difficult or impossible to compare the value of the given quantities since they would be different.

J. How could your parents select the best buy between food items on sale at local grocery stores? How could they compare homes that are for sale, or land that they may wish to purchase?

II. The English system of measurement

A. As a drafter, you will have to know how to read a ruler and make measurements. You are probably already familiar with the ruler and know how to measure in inches and feet. However, as a drafter, you will have to make measurements in fractions of an inch. (Use Trans. D3-2)

B. If you look at a common **ruler,** you will see that special marks divide each inch into several parts. Look at the pattern of the line lengths.

C. The longest lines locate the **inch** marks. The next longest lines are the **half-inch** marks. The third longest lines are the **one-fourth inch** marks. Next are the **one-eighth inch** marks, and the shortest are the **one-sixteenth inch** marks.

D. The **half-inch marks** divide an inch into two equal parts or halves.

E. The quarter-inch or **one-fourth inch** marks divide an inch into quarters, or four equal parts. The half-inch mark is also counted as a quarter-inch mark.

F. The eighth-inch marks divide an inch into eight equal parts. The quarter-inch and half-inch marks are also counted as eighth-inch increments.

G. The sixteenth-inch marks divide an inch into sixteen equal parts. When measuring in sixteenths of an inch, the eighth-inch, quarter-inch, and half-inch marks are also counted as sixteenths of an inch.

H. It is important that you learn to make accurate measurements because the drawings must indicate the correct sizes. If the **dimensions** are wrong on the drawing, the objects will be constructed wrong. This could result in a waste of time, money, and material.

III. The metric measurement system

A. The **metric system** is an international system of standard measurement. It is actually an easier system of measuring than the English system. The metric system allows measurements to be converted by simply moving the decimal.

B. The linear measure in metrics is the **meter**. As a drafter, you will need to know how to measure using a metric ruler. Metric rulers are usually available in meter, half-meter, and 30-centimeter sizes.

C. Metric rulers are divided into **centimeters** and **millimeters**. There are 100 centimeters to a meter, and 1,000 millimeters to a meter. (Use Trans. D3-3)

D. The centimeter divisions on a metric ruler are indicated by the numbers 1, 2, 3, 4, and so forth. Each centimeter is divided into 10 millimeters. Each division mark between centimeters represents one millimeter.

E. Remember that each **centimeter** is equal to 10 millimeters. When measuring in millimeters, multiply the centimeter number by 10 and add the remaining millimeters. To represent the centimeter measurement, read the centimeter and record it, place a decimal after the number, and then record the number of millimeters after it. This will give you a decimal number, but the centimeters, millimeters, or meters can be determined readily from this number.

IV. Scaled measurements (Use Trans. D3-4)

A. Usually, it is necessary to draw an object either larger or smaller than its actual size. For example, a house cannot be drawn to true size because it will not fit on a piece of drafting paper. It must be scaled and drawn at a different size. Small electronic devices in computer games are too small to draw to true size, so they must be drawn much larger.

B. If you examine the box that a model car or airplane comes in, you will see that it is one-quarter, one-eighth, one-sixteenth, or some other fraction of the actual size of the real object.

C. Maps are drawn to **scale** also. It is impossible to draw a state or city its actual size on a piece of paper. Instead, they will be drawn to a different size to fit on the paper. The scale will be shown on the map so that an individual can determine distances. On some maps, one inch may represent a distance of 200 miles.

D. A house may be drawn to a scale in which 1/4 inch equals 1 foot. This means that a wall 40 feet long would be drawn 10 inches on the plan. Other, more convenient scales may be used. For example, one may use a scale of 1/2" = 1' or 1/8" = 1'.

E. Standard units of measure enable both the drafter and user of the drawings to understand the actual sizes represented. Most of the drawings that a drafter makes are drawn to some scale.

MATERIALS FOR STUDENTS

- Vocabulary worksheet
- Student Worksheet 1
- Student Worksheet 2
- Student Worksheet 3
- Rulers, tapes, yardsticks, and scales
- Maps
- Nails, pencils, paper clips, and so on

SUGGESTED STUDENT ACTIVITIES

1. Divide class members into groups. Each group should consist of three or four students. Have the students use various items (pencils, paper clips, nails, hands, fingers, and so on) to measure tabletops, workbenches, and room sizes. Have each group make a list of advantages and disadvantages for each item. Discuss the problems that groups encounter when a standard unit of measure is not used.
2. Have all students complete Student Worksheet 1. This worksheet will help students learn to measure in fourths of an inch. This activity should be fairly easy for most students to complete.
3. Have all students complete Student Worksheet 2. This worksheet will help students learn to measure in eighths of an inch. This activity will be more difficult than Worksheet 1, so additional time should be allotted. Some students may need to practice measuring in eighths of an inch on objects assigned by the teacher.
4. Have all students complete Student Worksheet 3. This worksheet will be very difficult for many students. They may need more practice. Teachers can assign certain classroom objects that these students can practice measuring.
5. Have the students practice measuring in the metric system by using a meter stick

or metric ruler. They can measure objects in the room such as tables, workbenches, students doors, windows, cabinets, and so forth. Have students record their measurements so they can be checked.

6. Have students measure the heights of all class members using both the English and metric systems. These heights should be recorded on graphs so they can be displayed and compared. Have students discuss the differences in the two systems.
7. Have students sketch the plan view of their lab. They should measure the outside walls and record their measurements on their sketches. Have them select a scale that is most appropriate for their work. Since a 50-foot wall cannot be drawn to full size on paper, they will have to solve this drafting problem. The scale of one inch equals one foot will also be too large. Give them time to experiment and find a solution. You may want to have them use graph paper for this activity.
8. Have students use maps and determine distances between points on that map by using the stated scale. Students can plan a trip and calculate the mileage from the starting point to their destination.

STUDENT WORKSHEETS 1-3 ANSWER KEY

STUDENT WORKSHEET 1

A-B 1/4
A-D 1 1/4
A-E 2
A-F 2 1/2
A-G 3 1/4
A-H 3 3/4
A-I 4 1/2
A-J 5
A-L 5 3/4
A-M 6 1/2
A-N 7
B-C 1/2
B-E 1 3/4
C-D 1/2
D-F 1 1/4
G-H 1/2
H-I 3/4
I-J 1/2
J-L 3/4
K-L 1/2
L-M 3/4
M-N 1/2

STUDENT WORKSHEET 2

A-B 1/8
A-C 3/8
A-D 3/4
A-E 1 1/8
A-F 1 1/2
A-G 1 7/8
A-H 2 1/4
A-I 2 5/8
A-J 3
A-K 3 3/8
A-L 3 5/8
A-M 4 1/8
A-N 4 1/2
A-O 4 7/8
A-P 5 1/4
A-Q 5 3/4
A-R 6 1/8
A-S 6 3/8
A-T 6 5/8
B-C 1/4
C-E 3/4
D-G 1 1/8
D-K 2 5/8
H-L 1 3/8
J-L 5/8
M-O 3/4
P-Q 1/2
R-T 1/2
R-U 7/8
T-U 3/8

STUDENT WORKSHEET 3

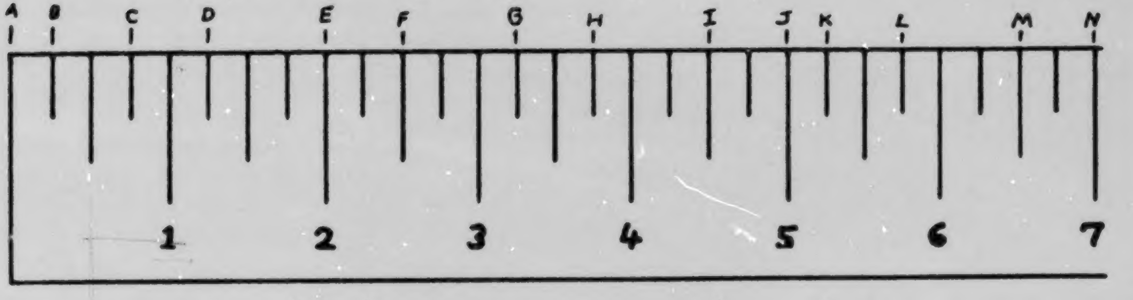
A-B 3/16
A-C 7/16
A-D 3/4
A-E 1 1/16
A-F 1 1/2
A-G 1 13/16
A-H 2 5/16
A-I 2 11/16
A-J 3 3/16
A-K 3 5/8
A-L 4
A-M 4 1/2
A-N 4 15/16
A-O 5 5/16
A-P 5 11/16
A-Q 6 1/16
A-R 6 3/8
A-S 6 13/16
A-T 7 1/8
B-F 1 5/16
E-G 3/4
H-J 7/8
I-J 1/2
J-M 1 5/16
L-M 1/2
M-O 13/16
N-O 3/8
P-R 11/16
Q-R 5/16
S-T 5/16

Vocabulary Worksheet

1. standard measurements
2. English system
3. metric system
4. ruler
5. inch
6. meter
7. centimeter
8. scale
9. half-inch
10. one-fourth inch
11. one-eighth inch
12. one-sixteenth inch
13. fraction
14. millimeter
15. dimensions

STUDENT WORKSHEET 1
MEASUREMENT

DIRECTIONS: The ruler shown below is divided into fourths of an inch. You are to record the measurement from one point on the ruler to another point on the ruler. For example, the measurement between points A-C is 3/4 inch. Below the ruler you will find several distances that you need to measure. Record your answer in the blank space to the right of the identified points.



A-B ________

A-D ________

A-E ________

A-F ________

A-G ________

A-H ________

A-I ________

A-J ________

A-L ________

A-M ________

A-N ________

B-C ________

B-E ________

C-D ________

D-F ________

G-H ________

H-I ________

I-J ________

J-L ________

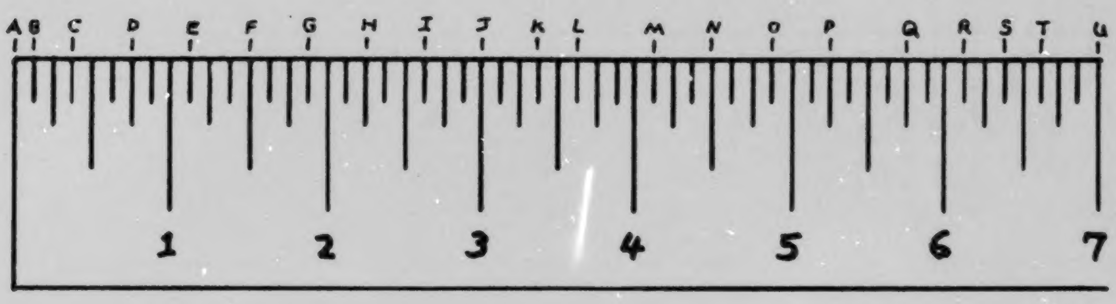
K-L ________

L-M ________

M-N ________

STUDENT WORKSHEET 2
MEASUREMENT

DIRECTIONS: The ruler shown below is divided into eighths of an inch. You are to record the measurement from one point on the ruler to another point on the ruler. For example, the measurement between points A-D is 3/4 inch. Below the ruler you will find several distances that you need to measure. Record your answer in the blank space to the right of the identified points.



A-B ________
A-C ________
A-D ________
A-E ________
A-F ________
A-G ________

A-H ________
A-I ________
A-J ________
A-K ________
A-L ________
A-M ________

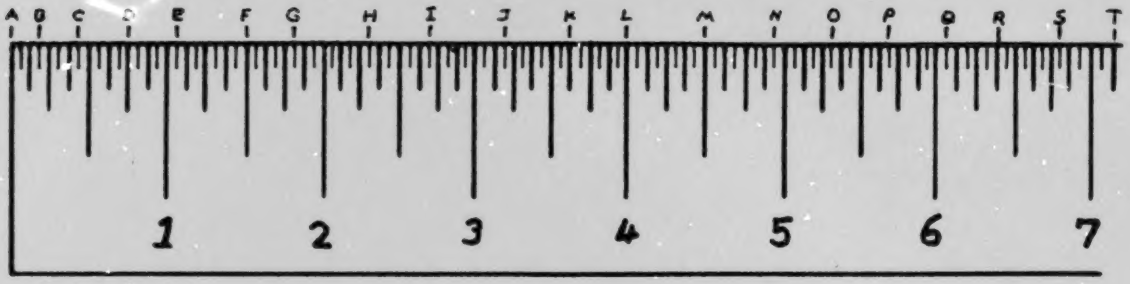
A-N ________
A-O ________
A-P ________
A-Q ________
A-R ________
A-S ________

A-T ________
B-C ________
C-E ________
D-G ________
D-K ________
H-L ________

J-L ________
M-O ________
P-Q ________
R-T ________
R-U ________
T-U ________

STUDENT WORKSHEET 3
MEASUREMENT

DIRECTIONS: The ruler shown below is divided into sixteenths of an inch. You are to record the measurement from one point on the ruler to another point on the ruler. For example, the measurement between points A-D is 3/4 inch. Below the ruler you will find several distances that you need to measure. Record your answer in the blank space to the right of the identified points.



A-B ________

A-C ________

A-D ________

A-E ________

A-F ________

A-G ________

A-H ________

A-I ________

A-J ________

A-K ________

A-L ________

A-M ________

A-N ________

A-O ________

A-P ________

A-Q ________

A-R ________

A-S ________

A-T ________

B-F ________

E-G ________

H-J ________

I-J ________

J-M ________

L-M ________

M-O ________

N-O ________

P-R ________

Q-R ________

S-T ________

TEST

Unit 3: Measurement

Directions: Read each statement carefully. Select the one word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank.

Example: _C_ 21. The class you are now attending is—

A. American Government
B. Language Arts
C. Industrial Arts
D. General Science

___ 1. The two standard systems of measurement used in the world today are—

A. English and British
B. English and metric
C. English and modern
D. modern and metric

___ 2. On a ruler, the longest lines mark the—

A. one-fourth inch marks
B. one-eighth inch marks
C. one-half inch marks
D. inch marks

___ 3. An inch that is divided into fourths will have—

A. three-fourths equal parts
B. eight equal parts
C. four equal parts
D. two equal parts

___ 4. An inch that is divided into sixteenths will have—

A. eight equal parts
B. one-sixteenth equal parts
C. 16 equal parts
D. 15 equal parts

___ 5. An international system of standard measurement is—

A. matrix
B. metric
C. American
D. British

___ 6. One meter contains—

A. 10 centimeters
B. 1 centimeter
C. 1,000 centimeters
D. 100 centimeters

___ 7. One meter contains—

A. 100 millimeters
B. 10 millimeters
C. 1,000 millimeters
D. 1 millimeter

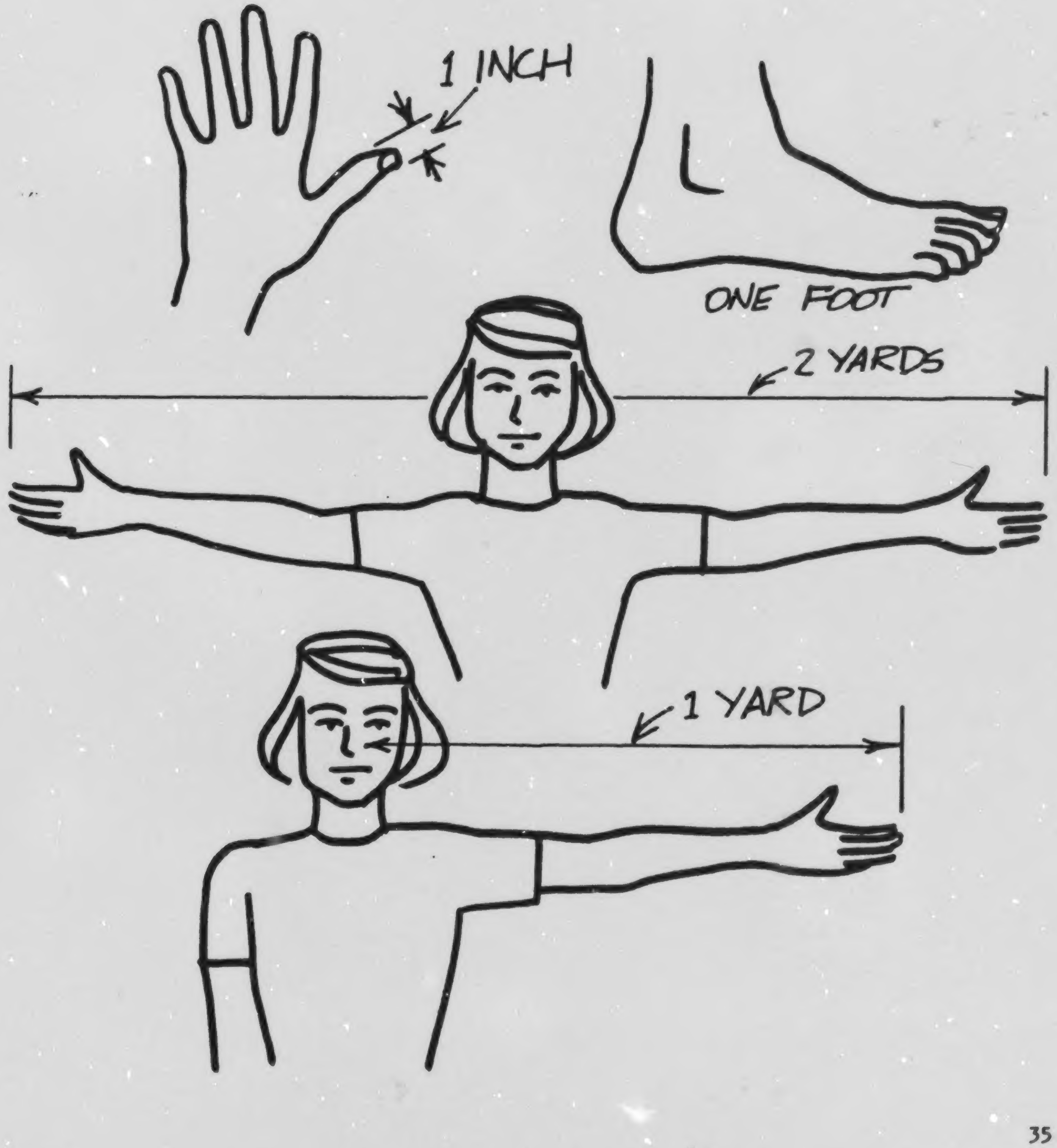
___ 8. One centimeter contains—

A. 10 meters
B. 10 millimeters
C. 100 millimeters
D. 100 meters

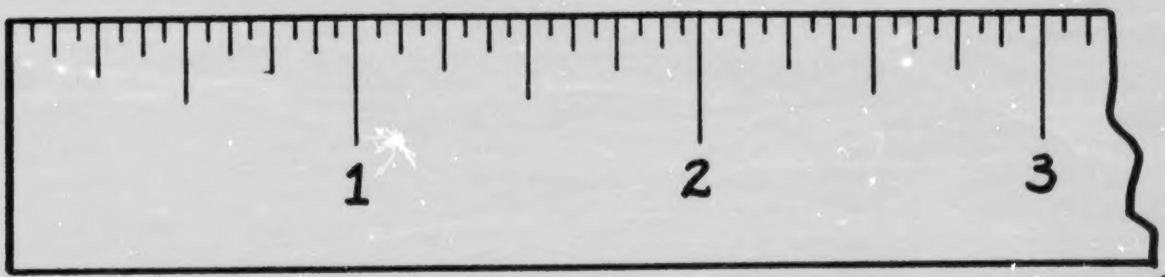
___ 9. Objects drawn larger or smaller than their true size are drawn to—

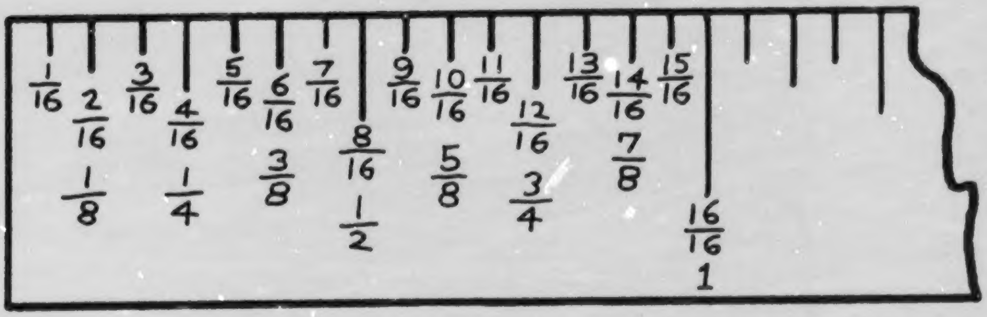
A. measurement
B. scale
C. scald
D. true-size

SOME EARLY STANDARDS OF MEASUREMENT

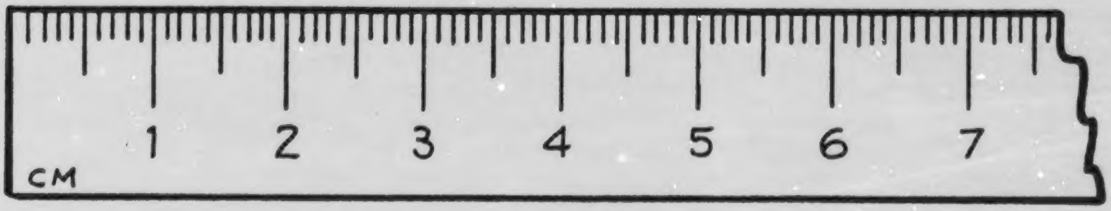

1 INCH
ONE FOOT
2 YARDS
1 YARD

STANDARD RULER MEASUREMENTS
IN SIXTEENTHS OF AN INCH

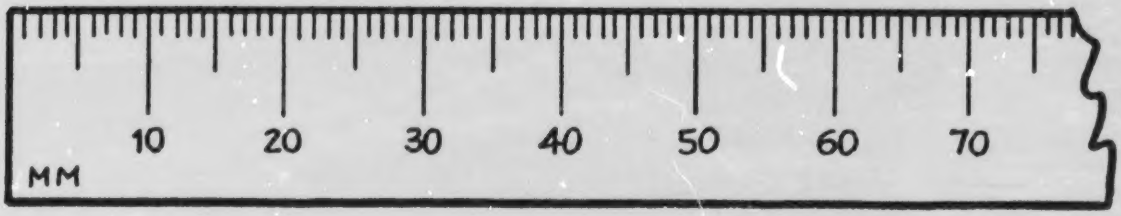



1/16
2/16
3/16
4/16
5/16
6/16
7/16
8/16
9/16
10/16
11/16
12/16
13/16
14/16
15/16
16/16
1/8
1/4
3/8
1/2
5/8
3/4
7/8
1

STANDARD RULER MEASUREMENTS IN THE METRIC SYSTEM



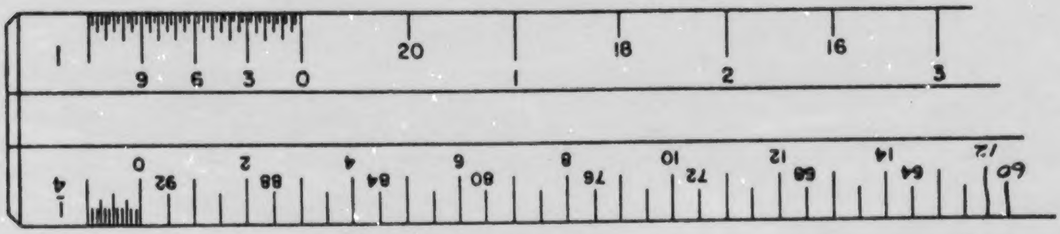
METRIC RULER MARKED IN CENTIMETERS


10
20
30
40
50
60
70
MM

METRIC RULER MARKED IN MILLIMETERS

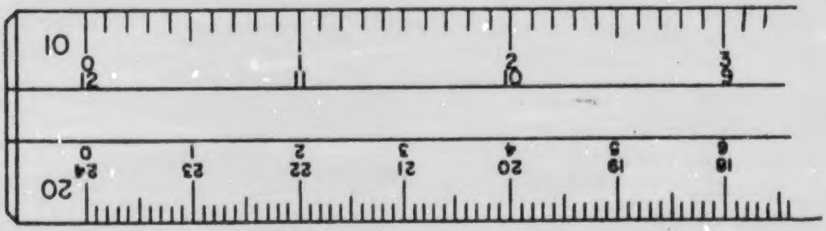
D 3-3

SCALES USED BY DRAFTERS



1
9 6 3 0
20
1
18
2
16
3
1/4
0 2 4 6 8 10 12 14 1/2
92 88 84 80 76 72 68 64 60

ARCHITECT'S SCALE



10
0 1 2 3
12 11 10 9
20
0 1 2 3 4 5 6
24 23 22 21 20 19 18

ENGINEER'S SCALE

4 Drafting in Industry

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. identify various tools, instruments, and equipment used by drafters; and
2. describe jobs that drafters may perform as part of their employment.

KEY WORDS: VOCABULARY

The following words may be new to students studying drafting. Teachers should help students understand these words as they are used in this topic of study.

- drafter
- drawings
- T square
- triangle
- technical illustrator
- compass
- divider
- template
- protractor
- drafting machine
- mechanical pencil
- scale
- computer

TEACHING AIDS

- Chalkboard
- Chalk and erasers
- Overhead projector and pointer
- Drafting set
- Triangles, protractors, compass
- Millikan Transparency/Duplicating Book. TDT12 Drafting Tools, Lines, and Circles. This book can usually be purchased from school supply businesses listed in the Yellow Pages.
- Test Key: 1-B, 2-C, 3-C, 4-A, 5-D, 6-D, 7-B, 8-C, 9-protractor, 10-triangle, 11-drafting machine, 12-scale, 13-bow compass, 14-circle template, 15-T square, 16-divider, 17-mechanical pencil, 18-drawing pencil
- Transparencies: You will find transparency masters D4-1 through D4-5 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to the students while they are studying different aspects of this unit. An explanation of each transparency follows.

D4-1: Pencils Used by Drafters; gives examples of some of the drawing and mechanical pencils drafters use.

D4-2: Drafting Tools and Instruments; provides illustrations of the T square, triangles, bow compass, divider, and protractor.

D4-3: Types of Scales Used in Drafting; provides illustrations of the architect's scale, civil engineer's scale, and mechanical engineer's scale.

D4-4: Examples of Templates Used in Industry; shows several templates that drafter use in their work.

D4-5: Drafting Machine; provides illustrations of a drafting machine and its parts.

SUGGESTED REFERENCES

Brown, W.C. Drafting for Industry. South Holland, Ill.: The Goodheart-Willcox Company, 1981.

Brown, W.C. Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1975.

Feirer, J.L., and Lindbeck, J.R. Basic Drafting. Peoria, Ill.: Charles A. Bennett Company, 1978. (Student workbook available.)

Feirer, J.L., and Lindbeck, J.R. Drawing and Planning for Industrial Arts. Peoria, Ill.: Charles A. Bennett Company, 1975.

Groneman, C.H., and Feirer, J.L. General Industrial Education. New York: McGraw-Hill Book Company, 1979.

Groneman, C.H., and Grannis, G.E. Exploring the Industries. Albany, N.Y.: Delmar Publishers, 1981.

Spence, W.P. Basic Industrial Drafting. Peoria, Ill.: Charles A. Bennett Company, 1979.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982. (Student workbook available.)

Wallach, P.I. The Basic Book of Drafting. Chicago, Ill.: American Technical Society, 1979.

SENTENCE OUTLINE

I. Working as a drafter in industry

   A. A **drafter** must become familiar with all the materials and manufacturing processes that are used by the company. Generally, individuals just starting in a drafting career will be given a period of training so they will become familiar with company procedures.

B. A beginning drafter may start by making **drawings** that do not require the skill and expertise of a more experienced drafter. After a worker gains experience and knowledge, more difficult drawings may be assigned.

C. Experienced drafters may be given drawings that require detailed illustration. They will usually be provided with less instruction and supervision.

D. Some drafters may work closely with engineers, designers, or researchers. These drafters will usually make drawings from the notes, sketches, or bits of information supplied by the professionals as they create new products or generate new ideas.

E. Drafters who work in the architectural industry will normally make drawings of commercial or residential structures. They may also be involved in environmental planning and model making. Other drafters may be assigned the task of developing plans for electrical systems, plumbing, or heating and air conditioning.

F. Industry employs **technical illustrators** to make illustrations that appear as lifelike as photographs. These illustrations are used to give assembly, installation, or manufacturers' information. Sales and advertising media also use illustrations made by technical illustrators.

II. Drafters use a variety of instruments, tools, and equipment

A. Drafters must develop skill in the use of many tools, instruments, and equipment necessary to do their job. Drafters must be able to work quickly and accurately. Their work must be neat and legible. (Use Transparency D4-1)

B. Drawing pencils come in a variety of grades from soft to very hard. A drafter must be familiar with these grades in order to select one that is appropriate for a certain type of drawing. The drafter must also be able to sharpen pencils correctly so the line thickness does not vary.

C. Mechanical pencils are also available to the drafter. These are easier to use than the drawing pencils. Instead of changing pencils, only the lead is changed. Newer types of mechanical pencils have the advantage of not having to have the lead sharpened. Drafters just select a **mechanical pencil** with the correct size lead for the line they want to draw. This makes drawing faster and more efficient. (Use Trans. D4-2)

D. Drafters must know how to use a T square. This tool is used to draw horizontal lines. It is also used as the base upon which triangles are placed. A T square looks like a big T.

E. The most common **triangles** that a drafter uses are the 45-degree and 30-60-degree triangles. These are used to draw vertical and slanted lines.

F. A **protractor** is used to measure and lay out angles on a drawing. Drafters must be able to read and calculate the degrees of a circle or a fraction of a circle.

G. Drafters must learn how to use compasses and dividers. A **compass** is used to draw arcs and circles. **Dividers** are used to lay out and check measurements. Drafters must develop skills in the use of both of these instruments to produce good drawings.

H. Many drawings are drawn to scale. "Drawn to scale" means that the size the object appears in the drawing is different than the true size of the object. Drafters must learn to make accurate scale drawings. (Use Trans. D4-3)

I. Drafters use three basic types of measuring **scales**. These are the architect's scale, the mechanical engineer's scale, and civil engineer's scale. Drafters must also know how to use a metric scale. The measurements on each of these scales are different. (Use Trans. D4-4)

J. Drafters also use **templates** to make their work easier and to reduce drafting time. Templates are normally made of plastic. They already have the shape of the object cut into them, and all the drafter has to do is trace around it. They are used in industry because they decrease the amount of time required to do a drawing. In other words, they increase efficiency.

Templates can be purchased in many different symbols or signs. Drafters can use lettering templates, circle or ellipse templates, and electrical, welding, or piping templates. Other templates can be used to produce architectural symbols. (Use Trans. D4-5)

K. The **drafting machine** has replaced T squares, triangles, and protractors and scales in industry and most drafting programs. These machines make drafting more efficient. These specially designed machines incorporate a protractor that rotates 360° and specially designed scales that extend vertically and horizontally and also act as a T square. A drafting machine requires more skill to use than other drafting tools.

L. In many business organizations, drafters use **computers** to do the work they once did by hand. Workers entering the drafting occupation would do well to acquire a working knowledge of computers and their use in drafting.

M. Some computers use a paper tape that has been programmed with specific instructions. The computer interprets the instructions and draws the object with the use of special mechanical pencils.

N. Other computers use a keyboard that permits the operator to enter information on magnetic discs or tapes. These instructions are used to draw the object. Some computers allow the drafter to view the design on a video screen before it is drawn in final form. Changes can be made by using a special light-emitting pen against the video screen.

O. Drafters need to become familiar with the many ways that computers are used in the field of drafting. To be efficient workers, they need to have a basic knowledge of programming, computer language, and how computers make drawings.

P. Computers increase the efficiency of drafters by allowing parts to be increased or reduced in size very rapidly, by allowing changes to be made quickly, and by providing a memory that can store large quantities of data regarding sizes, styles, materials, and so forth.

MATERIAL FOR STUDENTS

- Vocabulary Worksheet
- Word Puzzle Activity
- Drafting tools and instruments

SUGGESTED STUDENT ACTIVITIES

1. Have students identify local businesses that employ drafters. Work with the students to help them identify one or two workers that they would like to invite for a class visit. To avoid communication problems, the teacher should contact the individuals and extend invitations on behalf of the class. Students should make a list of questions they want to ask these visitors during the class visit.
2. Have each student complete the Vocabulary Worksheet.
3. Have students complete the Word Puzzle Activity. They should be permitted to use the necessary drafting tools and instruments to complete the activity. They may want to do more than one puzzle. Save this activity and have students compare it to a similar activity in Unit 5.

Vocabulary Worksheet

Directions: Using the following list of words, explain the purpose of each tool or instrument:

1. T square
2. triangle
3. compass
4. divider
5. template
6. protractor
7. drafting machine
8. mechanical pencil
9. scale
10. computer
11. technical illustrator
12. drafter
13. drawings

Word Puzzle Activity

Directions: Using the drafting tools and instruments described in this unit, draw a 20 x 20 in. grid. Each square on the grid should be 1/4" x 1/4". Use the words in either column A, B, or C and make a find-a-word puzzle. Words can be spelled forward or backward, vertically, horizontally, or on the diagonal.

A

Drafting
Drafter
Industry
Alphabet
Language
Triangle
T square
Protractor
Visible Line

B

Template
Divider
Compass
Mechanical Pencil
Scale
Symbols
Lines
Gothic
Computer

C

Break Line
Sketch
Drawing
Communicate
Engineer
Architect
Single-stroke
Drafting Machine
Center Line

TEST

Unit 4: Drafting in Industry

Directions: Read each statement carefully. Select the one word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank.

Example: _C_ 21. The class you are now attending is—

A. American Government
B. Language Arts
C. Industrial Arts
D. General Science

___ 1. Drafters who work closely with engineers will usually make drawings from—

A. pictures and photographs
B. notes and sketches
C. recordings and manuscripts
D. finished drawings

___ 2. Individuals who make illustrations that appear as lifelike as a photograph are called—

A. mechanical drafters
B. portrait artists
C. technical illustrators
D. engineering drafters

___ 3. The tool used to draw horizontal lines is a—

A. ruler
B. straightedge
C. T square
D. chalk line

___ 4. The most common triangles that a drafter uses are the—

A. 45-degree and 30-60-degree
B. 45-degree and 90-90-degree
C. 55-degree and 30-60-degree
D. 45-degree and 55-degree

___ 5. The instrument that a drafter uses to lay out and measure angles is a—

A. compass
B. angle template
C. T square
D. protractor

___ 6. The instrument that a drafter uses to draw arcs and circles is a—

A. divider
B. drafting machine
C. engineer's scale
D. compass

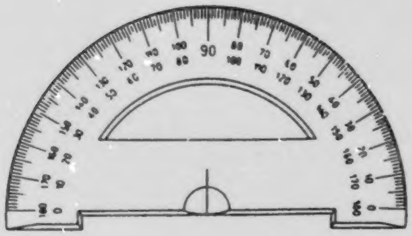
___ 7. When the size of the object in the drawing is different than the true size of the object, it is said to be drawn to—

A. measurement
B. scale
C. metric standards
D. English standards

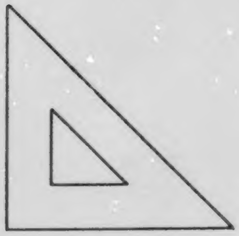
___ 8. An instrument that a drafter uses to lay out and check measurements is a—

A. compass
B. mechanical pencil
C. divider
D. pointer

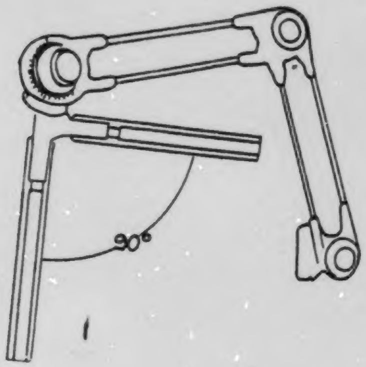
Directions: Identify each of the following items using its correct name.



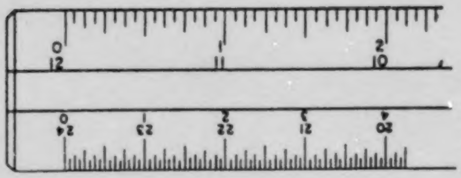
9. ______________________________



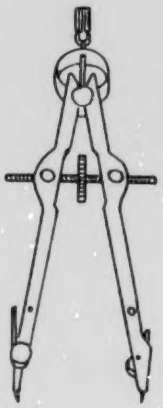
10. ______________________________



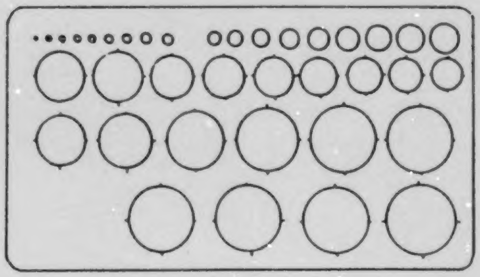
11. ______________________________


0
12
1
11
2
10
0
24
1
23
2
22
3
21
4
20

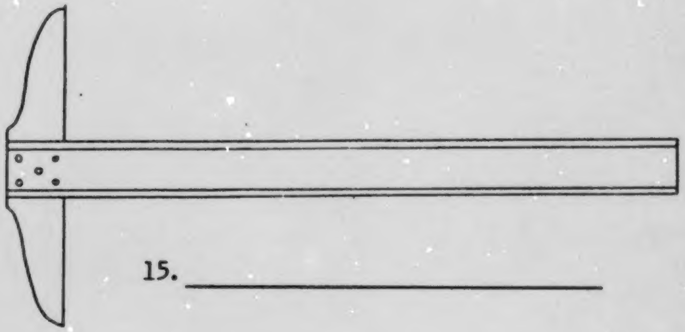
12. ______________________________



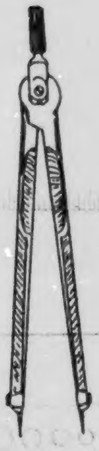
13. ______________________________



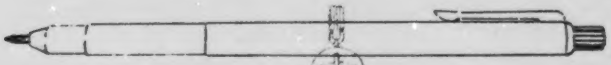
14. ______________________________



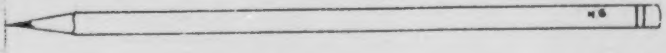
15. ______________________________



16. ______________________

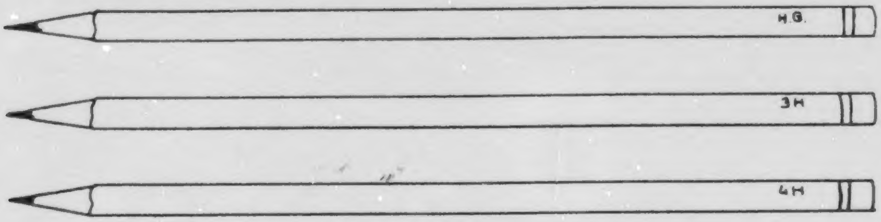


17. ______________________

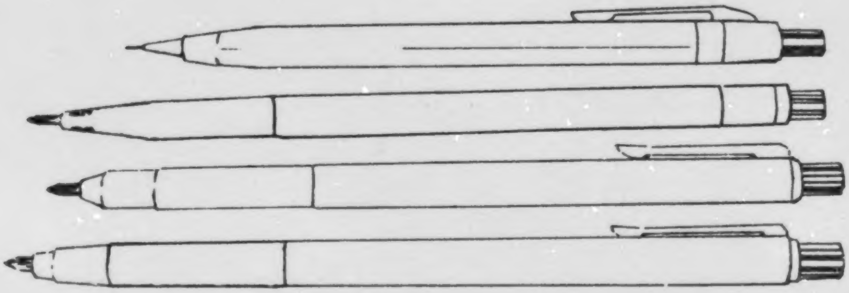


18. ______________________

PENCILS USED BY DRAFTERS

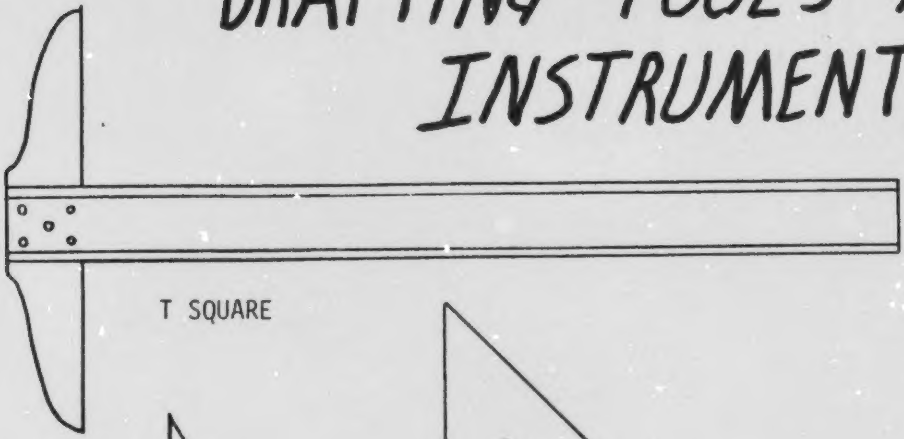


DRAWING PENCILS

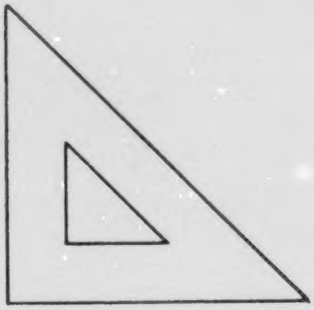


MECHANICAL PENCILS

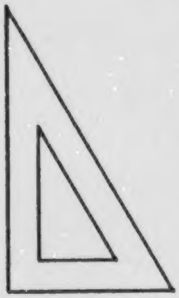
DRAFTING TOOLS AND INSTRUMENTS



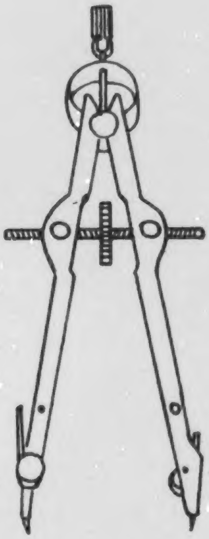
T SQUARE



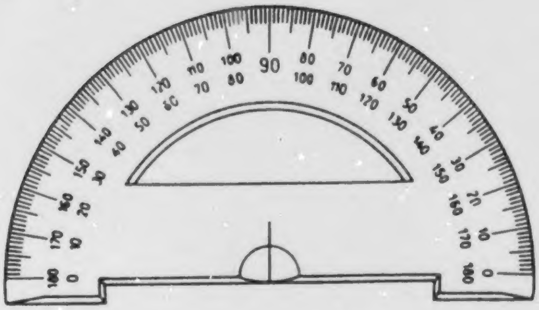
45° TRIANGLE



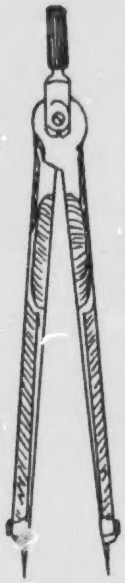
30°- 60° TRIANGLE



BOW COMPASS

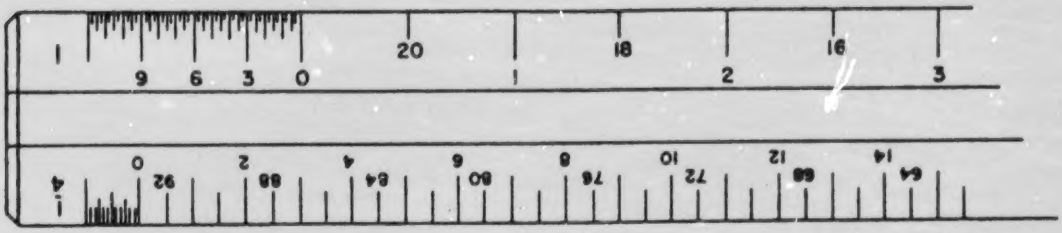

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

PROTRACTOR

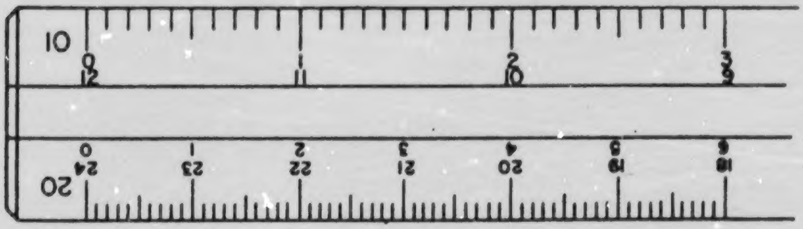


DIVIDER

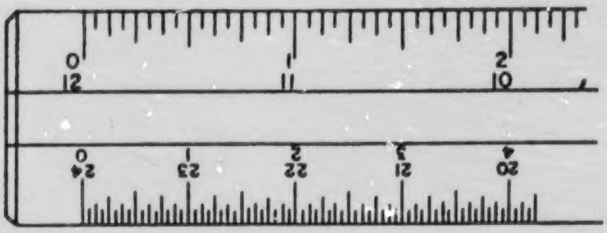
TYPES OF SCALES USED IN DRAFTING


1
9 6 3 0
20
1
18
2
16
3
0 2 4 6 8 10 12 14
92 88 84 80 76 72 68 64

ARCHITECT'S SCALE

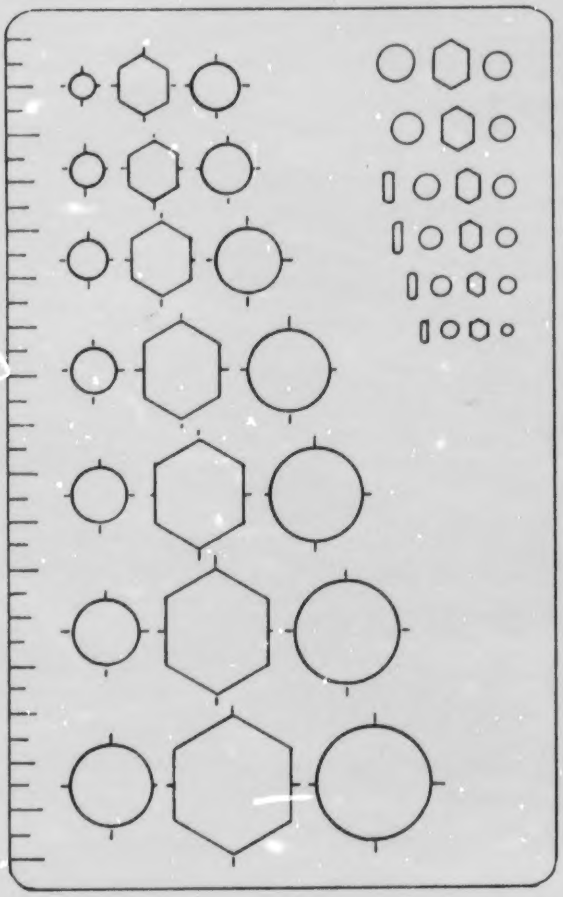

10
0 1 2 3
12 11 10 9
20
0 1 2 3 4 5 6
24 23 22 21 20 19 18

CIVIL ENGINEER'S SCALE

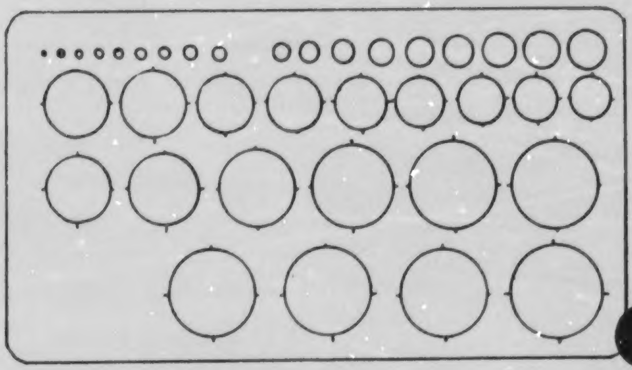

0 1 2
12 11 10
0 1 2 3 4
24 23 22 21 20

MECHANICAL ENGINEER'S SCALE

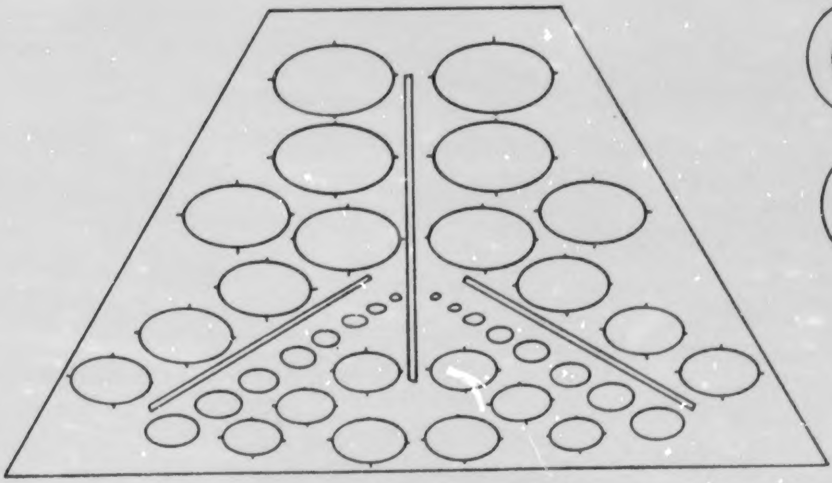
EXAMPLES OF TEMPLATES USED IN INDUSTRY



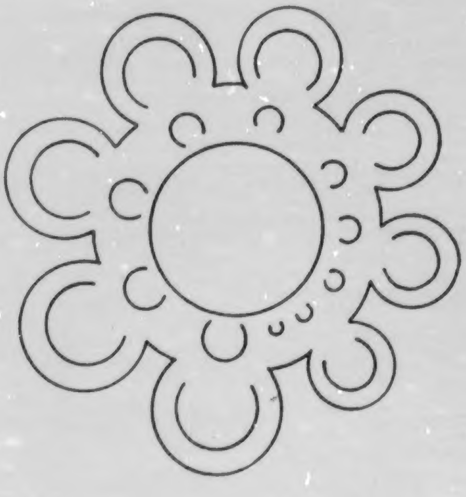
HEXAGON BOLTS & NUTS



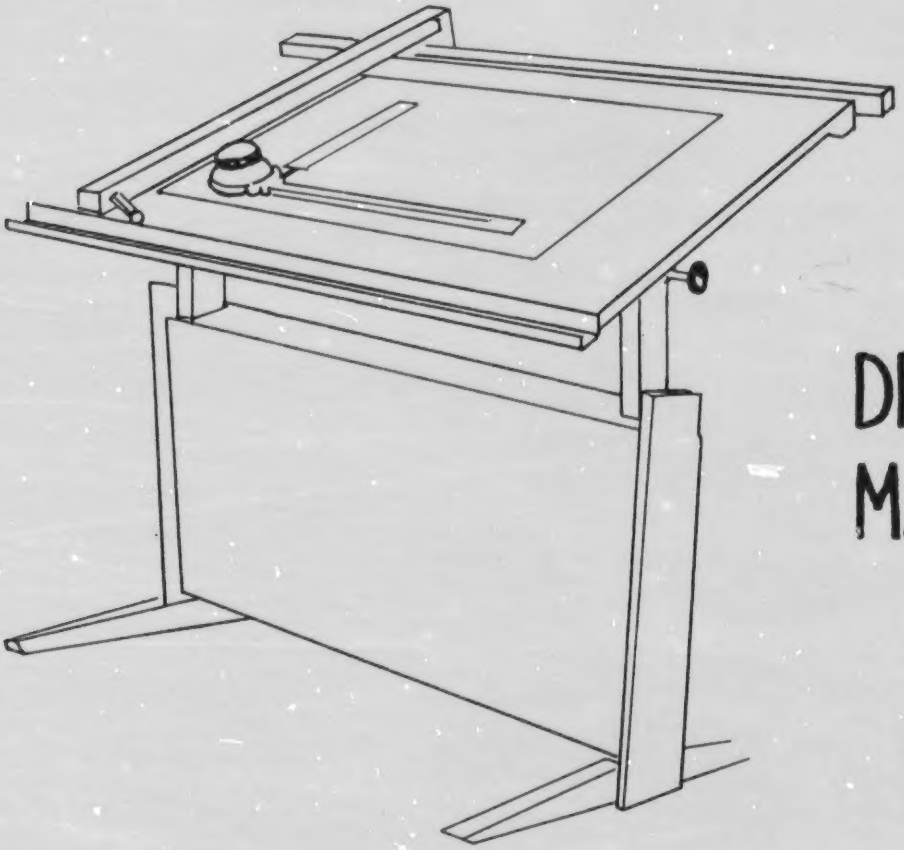
METRIC CIRCLES



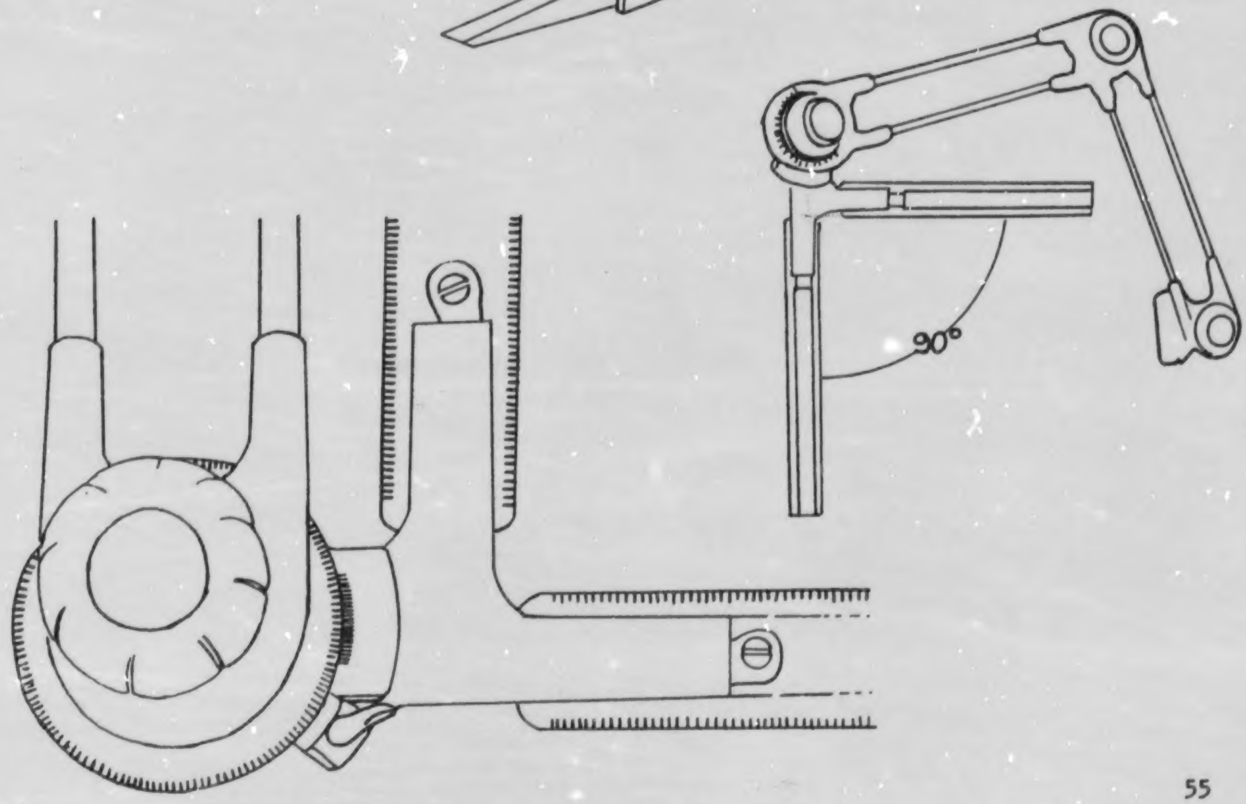
ISOMETRIC ELLIPSES



RADIUS GUIDE



DRAFTING MACHINE



5 The Drafting Language

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. compare the drafting language with other language forms;
2. identify uses of the drafting language in society;
3. describe ways in which the drafting language enables workers in industry to communicate efficiently;
4. demonstrate the use of single-stroke Gothic letters; and
5. demonstrate the use of and identify the alphabet of lines.

KEY WORDS: VOCABULARY

The words listed below may be new to the student studying drafting. Teachers should help students understand these words as they are used in this topic of study.

lines
hidden lines
center lines
extension lines
break lines
Gothic
visible lines
invisible lines
dimension lines
section lines
letters
symbols

TEACHING AIDS

- Chalk and erasers
- Overhead projector and pointer
- Milliken Transparency/Duplicating Books. TDT11 Lettering, Scales, and Sketching; TDT12 Drafting Tools, Lines, and Circles. These books can usually be purchased through school supply businesses listed in the Yellow Pages.
- Test Key: 1-D, 2-C, 3-C, 4-B, 5-A, 6-C, 7-D (8 and 9 to be checked by teacher)
- Transparencies: You will find transparency masters D5-1 through D5-5 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to the students while they are studying different aspects of this unit. An explanation of each transparency follows.

D5-1: Use of Lines in Everyday Life; provides examples of some uses of lines on highways and in games.
D5-2: Alphabet of Lines; shows some of the standard lines used in drafting.
D5-3: Vertical Single-Stroke Gothic Alphabet; illustrates letters and numbers in this alphabet as well as the procedure for making them.
D5-4: Standard Drafting Symbols; illustrates some of the standard electrical symbols and some of the standard symbols found on road maps.
D5-5: Standard Drafting Symbols; illustrates some of the standard welding symbols and some of the standard symbols used in architectural drafting.

SUGGESTED REFERENCES

Brown, W.C. Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1975.

Brown, W.C. Drafting for Industry. South Holland, Ill.: The Goodheart-Willcox Company, 1981.

Feirer, J.L., and Lindbeck, J.R. Basic Drafting. Peoria, Ill.: Charles A. Bennett Company, 1978. (Student workbook available.)

Feirer, J.L., and Lindbeck, J.R. Drawing and Planning for Industrial Arts. Peoria, Ill.: Charles A. Bennett Company, 1975.

Groneman, C.H., and Feirer, J.L. General Industrial Education. New York: McGraw-Hill Book Company, 1979.

Groneman, C.H., and Grannis, G.E. Exploring the Industries. Albany, N.Y.: Delmar Publishers, 1981.

Miller, W.R., and Ross, S. Drafting. Bloomington, Ill.: McKnight Publishing Company, 1978.

Spence, W.P. Basic Industrial Drafting. Peoria, Ill.: Charles A. Bennett Company, 1979.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982. (Student workbook available.)

Wallach, P.I. The Basic Book of Drafting. Chicago, Ill.: American Technical Society, 1979.

Wallach, P.I. Drafting. Encino, Calif.: Glencoe Publishing Company, 1981. (Student workbook available.)

Yaslow, S. Elements of Mechanical Drafting. Albany, N.Y.: Delmar Publishers, 1979. (Student workbook available.)

SENTENCE OUTLINE

I. The language structure of drafting
  A. Like other forms of written communication, drafting uses a standardized system that incorporates lines, letters, and symbols. Each line, letter, or symbol can be deciphered just as the words of a sentence can be examined for meaning.
  B. In grammar, there is a difference in meaning among sentences that end with a period, a question mark, or an exclamation mark. Quotation marks also provide additional meanings for the reader. In drafting, different lines also represent different meanings to the person reading a drawing.
  C. Many different styles of lettering can be used by a drafter. The style used will depend upon what the drafter is trying to convey. Lettering on architectural or mechanical drawings is not the same as the lettering used on signs, maps, or charts.
  D. A variety of symbols are also used by drafters to communicate easily with workers who use the drawings. Welders learn drafting symbols that enable them to read and comprehend drawings. Electricians, carpenters, and plumbers are just a few of the workers that must also learn to read some of the specialized symbols of the drafting language.

II. Lines (Use Transparency D5-1)
  A. Every day, we see **lines** that provide meaning for us. Paper that we write on has lines that identify the margins and writing space. Highways are divided with center lines that may be solid or broken. We know the meaning of both when they are used on the highway. Games such as tennis, basketball, football, hopscotch, baseball, and shuffleboard are played on fields or courts that have lines with special meaning.
  B. In drafting, lines have special meanings also. The American Society of Mechanical Engineers has developed a standard for lines that is accepted throughout industry. Each person, therefore, knows and interprets a particular line as having the same meaning.
  C. Lines are used to reveal shapes, sizes, hidden surfaces, and interior details, as well as other details of an object. Lines differ in width and character so that each is easily distinguishable from another. Each line conveys a different meaning.
  D. Some of the lines drafters must understand and use are **visible lines, hidden lines, section lines, center lines, break lines, dimension lines,** and **extension lines.** Workers who must use drawings in their work must also understand the meaning and use of these lines.

III. Lines and their meaning (Use Trans. D5-2)
  A. **Visible lines** are represented by a solid, heavy line that shows all the edges of a surface that can be seen from the position of the observer.
  B. **Hidden** or **invisible lines** are represented by lines that consist of short dashes. These lines are not quite as heavy as the visible lines. Hidden or invisible lines are used to show edges of a surface that cannot be seen from the position of the observer.
  C. **Center lines** are medium lines that consist of a long dash, a short space, a short dash, another short space, then a long dash again. The center line is used to divide a drawing into equal parts and to locate the center of arcs and circles.
  D. **Extension lines** are thin, light, solid lines. They are an extension of the visible object lines. They are used in conjunction with the dimension lines to show the measurements of an object.
  E. **Dimension lines** are thin, light, solid lines with a space in the center for placing the measurement. These lines are placed between two extension lines to show the distance from one to the other. Arrowheads are drawn on the ends of the dimension lines.
  F. **Section lines** are light, solid lines drawn at a slant of about 45 degrees on a sectional drawing. The section lines indicate that a part of the object has been cut away to show other details.

G. **Break lines** are medium-weight lines that are used to indicate that a portion of an object was not drawn. The break lines may be used when the object is too large to fit on the drawing or when an outer surface is cut away to show details behind the surface. Break lines may appear as either wavy lines or as ruled lines with freehand zigzags.

IV. Letters (Use Trans. D5-3)

A. Many types of **letters** are used every day in the world of work. Different styles of letters can be found in a single newspaper. Magazines, billboards, posters, and other advertising media use many styles of letters to attract attention and make their message stand out.

B. Drafters also use lettering on their drawings. The purpose of lettering on a drawing is to further clarify the views by providing notes that specify material and processes. Lettering that is difficult to read could contribute to costly errors in production and servicing of parts, machines, and other products.

C. The American National Standards Institute recommends the single-stroke **Gothic** alphabet for drawings. These letters are easy to make and are highly legible.

D. Lettering can be very time-consuming. In industry, many companies provide lettering aids so their drafters can be more productive. Many devices are available that increase the speed of lettering. Some of these devices are special typewriters for use on drawings, computerized printers that print information on drawings, templates, and lettering guides.

V. Symbols (Use Trans. D5-4 and D5-5)

A. **Symbols** are signs that have a definite meaning. Symbols are used every day to communicate information. A red light has one meaning while a green light has another. The silhouette on a restroom door indicates whether it is for men or women. Reserved parking spaces for the handicapped are designated by a special symbol. There are many others that we see each day. What others can you think of?

B. Symbols used in drafting eliminate the need for lengthy explanations on most drawings. Standardized symbols, which are accepted throughout industry, enhance the appearance of drawings and contribute to better readability.

C. All individuals who use drawings in their work must understand standard symbols found on their particular drawings. Electricians must know what each electrical symbol means. Architectural drafters must know a variety of symbols used in their work. Welders must become familiar with symbols used in their trade. How many other workers can you think of that might need to know what particular drafting symbols mean?

MATERIALS FOR STUDENTS

- D5-2: Alphabet of Lines (overhead projector)
- D5-3: Vertical Single-stroke Gothic Alphabet (as a handout)
- Student Worksheet 1
- Student Worksheet 2
- Magazines, newspapers, maps, and so forth
- Poster board, glue, scissors
- Magic markers
- Rulers

SUGGESTED STUDENT ACTIVITIES

1. Have the students use the Student Worksheet 1 and practice making single-stroke Gothic letters. You may want to duplicate transparency master D5-3 and give it to students as a handout. If you have left-handed students in your class, you may want to use the illustration of figure 12-6, page 75, in Basic Drafting. Have the students compare the results of this activity with their normal handwriting. Which is more legible?
2. Have the students use the Student Worksheet 2 and write the quotation using single-stroke Gothic letters. Have them write the quotation on another sheet of paper in their usual writing and compare the two samples. Which is more legible? Why would one be preferred over the other?
3. An alternative to Activity No. 2 is to have students use the vocabulary words

and make a find-a-word puzzle. They can compare the results of this lettering activity to the word puzzle they made in Unit 4.

4. Have the students develop a class organization chart that identifies each management position (i.e., shop foreman, machine foreman, clean-up foreman, tool foreman) and the names of each class member in the correct management and worker position.
5. Have the students make safety posters for the equipment in the industrial arts lab. The posters can be placed near each piece of equipment so they are readily available to the user. Safety posters may be entered into state competition events.
6. Divide the class into groups. Each group should have three or four student members. Have each group make a list of all the rock music groups or singers they can think of. They can use other categories to make lists also, (i.e., teachers' names, students' names, designer clothes, football players, and team names). After they have listed as many names as possible, have each group member make a word puzzle that uses words from their list. Remember this is a lettering activity, so all lettering should conform to good practices.
7. Save the comics sections of newspapers, and use them in lettering activities. Use the favorite cartoon characters of your students, and have them letter the conversations that occur. Cut out the comic strip and the conversations and then make a copy or copies for student use. Have the students develop their own dialog for the cartoon characters.

   They should use good lettering practices to write the dialog in the comic strip. You may want to have your students sketch their own cartoon characters and develop their own cartoon strips. Each strip can consist of from one to four or more frames.
8. Use transparency master D5-2 on the overhead projector, and have students practice making each of the lines. Have them make each line five times across the width of an 8-1/2 x 11 in. sheet of paper. Figure 43, page 45, in Exploring Drafting, provides good examples that you may want to use with your students.

Vocabulary Worksheet

1. lines
2. hidden lines
3. visible lines
4. invisible lines
5. center lines
6. dimension lines
7. extension lines
8. section lines
9. break lines
10. letters
11. Gothic
12. symbols

STUDENT WORKSHEET 1

Directions: Use the space provided below and practice making single-stroke Gothic letters and numbers. Start on the line with the *. Leave a blank line between each line you use.

*

STUDENT WORKSHEET 2

Directions: In the space provided below, use single-stroke Gothic letters, and write the following phrase as many times as you can. "Here men from the planet earth first set foot upon the moon, July 1969 A.D. We came in peace for all mankind." Start on the line with the *. Leave a blank line between each line you use.

*

TEST

Unit 5: The Drafting Language

Directions: Read each statement carefully. Select the one word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank.

Example: _C_ 21. The class you are now attending is—

A. American Government
B. Language Arts
C. Industrial Arts
D. General Science

___ 1. The language structure of drafting is like other forms of—

A. oral communication
B. auditory communication
C. electronic communication
D. written communication

___ 2. Drafting uses a standardized system which incorporates—

A. lines, symbols, and drawings
B. drawings, photographs, and lines
C. lines, letters, and symbols
D. lines, letters, and drawings

___ 3. Shapes, sizes, hidden surfaces, and interior details are represented by—

A. symbols
B. texture
C. lines
D. color

___ 4. Solid, heavy lines that show all the edges of a surface from the observer's position are—

A. extension lines
B. visible lines
C. break lines
D. section lines

___ 5. Lines placed between two extension lines to show the distance from one to the other are—

A. dimension lines
B. distance lines
C. visible lines
D. break lines

___ 6. Lines used to show edges of a surface that cannot be seen from the position of the observer are—

A. extension lines
B. section lines
C. hidden lines
D. dimension lines

___ 7. The need for lengthy explanations on drawings is often eliminated by the use of—

A. single-stroke Gothic letters
B. hidden lines
C. center lines
D. symbols

___ 8. Draw each of the lines listed below—

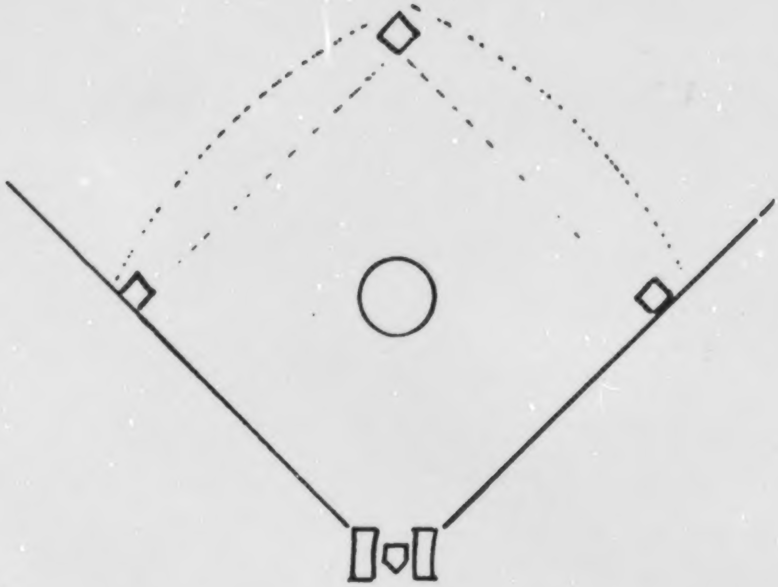
A. center line—

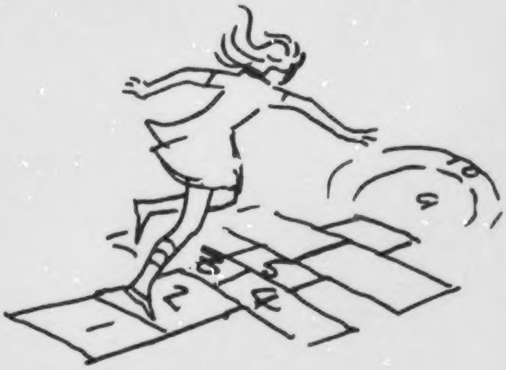
B. visible line—

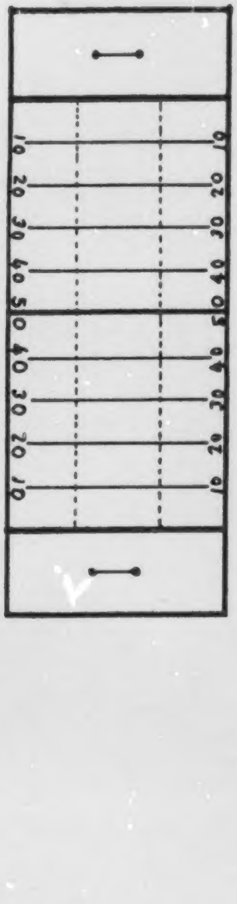
C. hidden line—

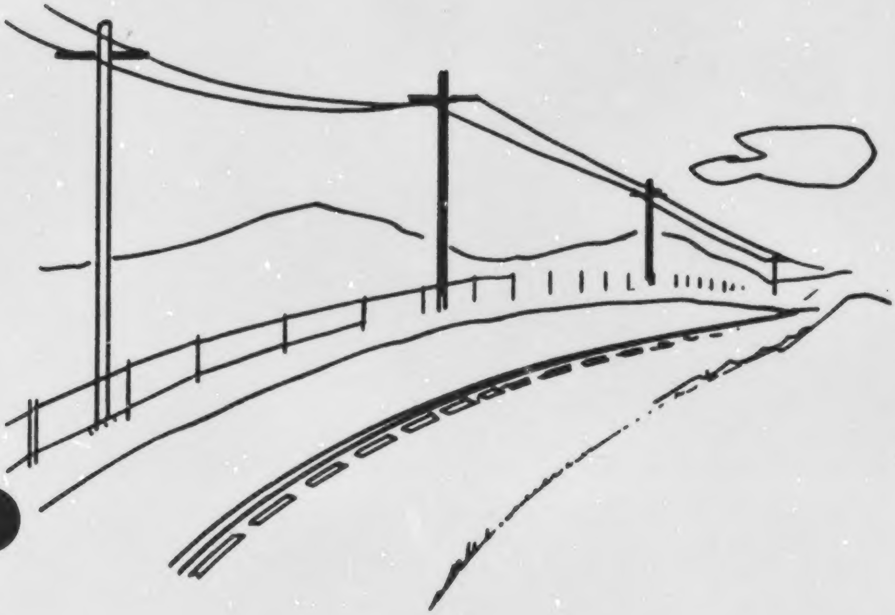
9. In the space that follows, use your instruments and set up guidelines for lettering the following statement. Use single-stroke Gothic letters. "Red Willow Junior High Industrial Arts won Best in State five years in a row."

USES OF LINES IN EVERYDAY LIFE

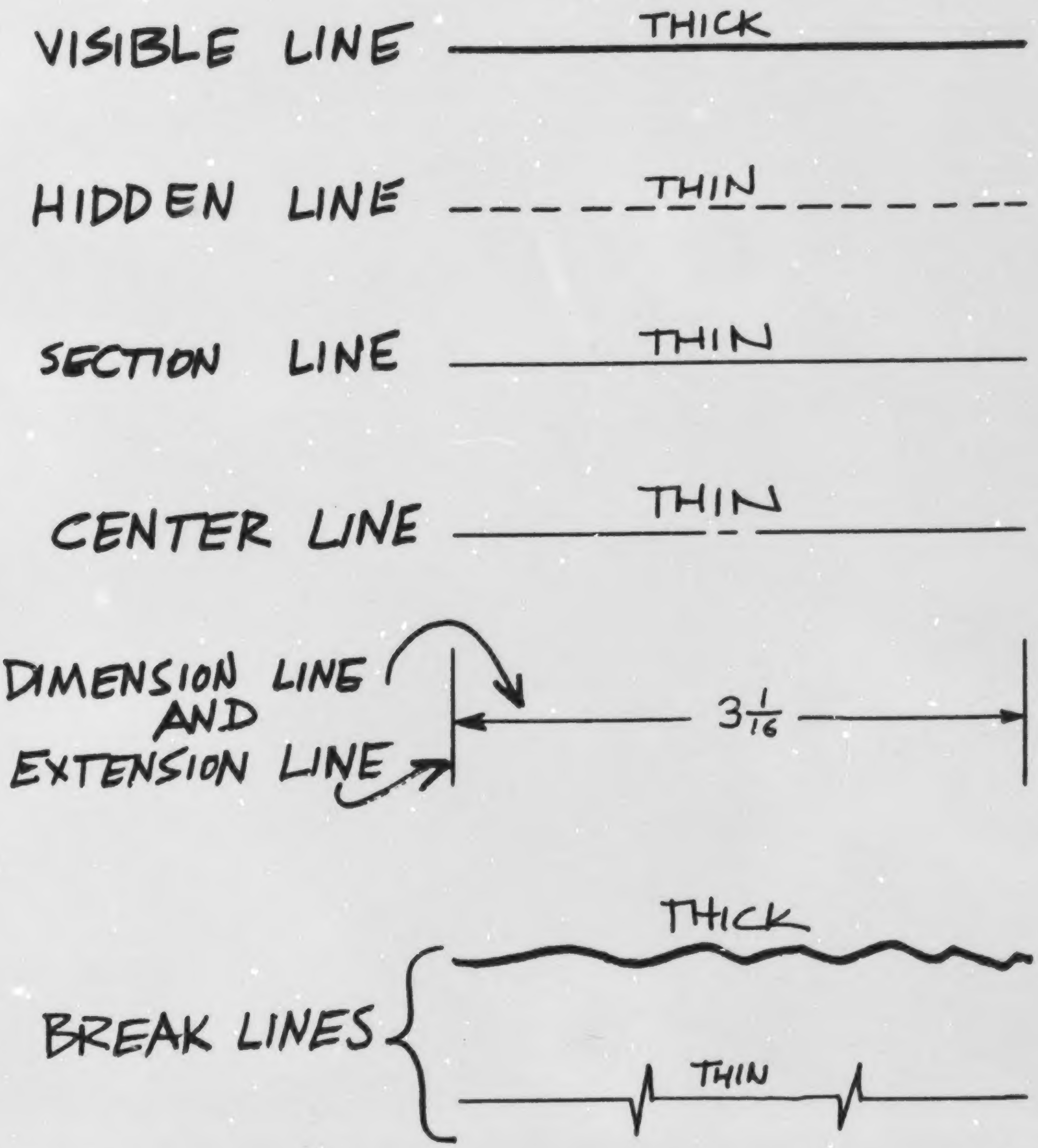




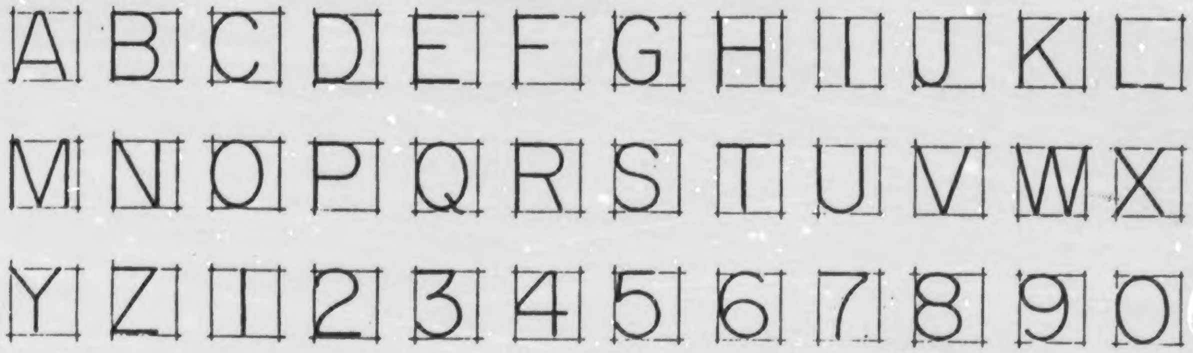

10
20
30
40
50
40
30
20
10

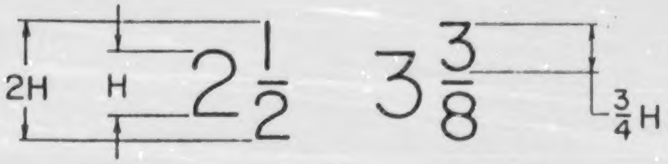


ALPHABET OF LINES

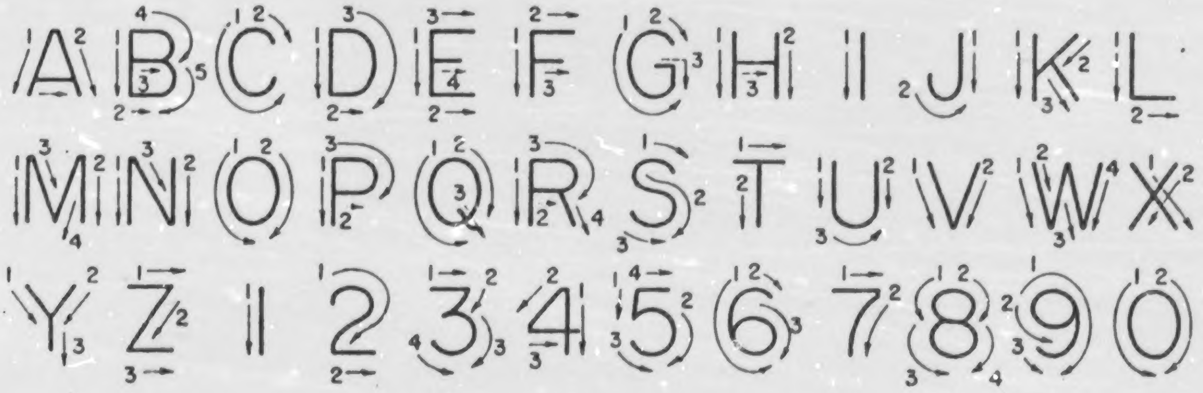

VISIBLE LINE
THICK
HIDDEN LINE
THIN
SECTION LINE
THIN
CENTER LINE
THIN
DIMENSION LINE
AND
EXTENSION LINE
$3\frac{1}{16}$
THICK
BREAK LINES
THIN

VERTICAL SINGLE-STROKE GOTHIC ALPHABET

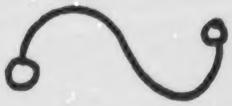

A B C D E F G H I J K L
M N O P Q R S T U V W X
Y Z 1 2 3 4 5 6 7 8 9 0

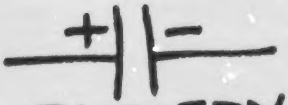

2H
H
$2\frac{1}{2}$
$3\frac{3}{8}$
$\frac{3}{4}$H

RECOMMENDED SEQUENCE FOR MAKING SINGLE-STROKE GOTHIC ALPHABET

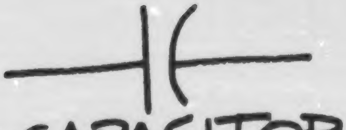

A B C D E F G H I J K L
M N O P Q R S T U V W X
Y Z 1 2 3 4 5 6 7 8 9 0

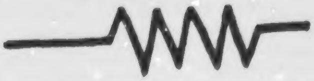
STANDARD DRAFTING SYMBOLS

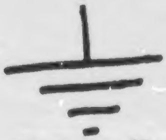

FUSE

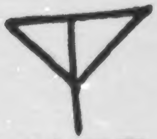


BATTERY

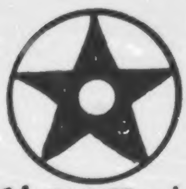

CAPACITOR

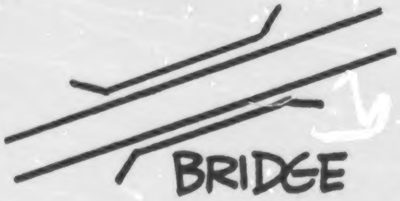

RESISTOR

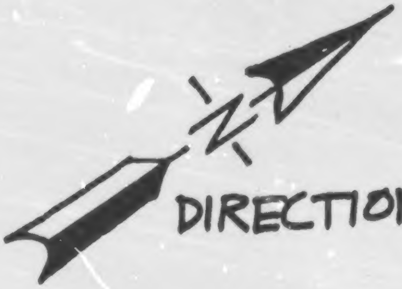

GROUND

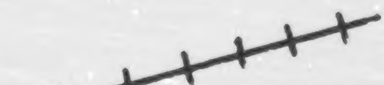

GENERAL ANTENNA

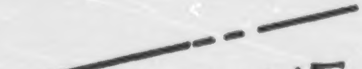
ELECTRICAL SYMBOLS

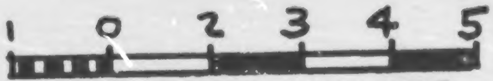

CAPITOL


BRIDGE


DIRECTION


RAILROAD

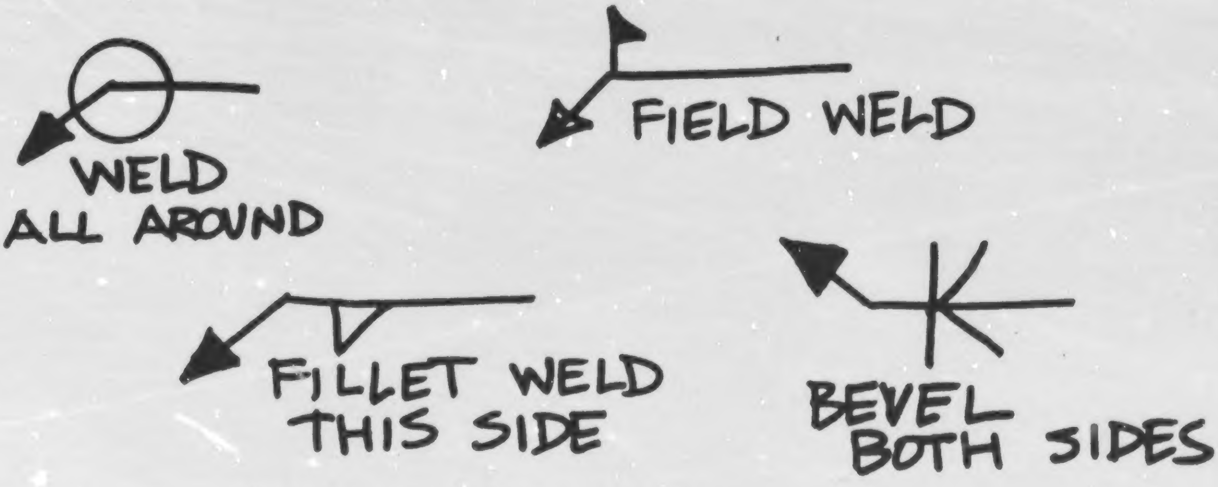

STATE LINE



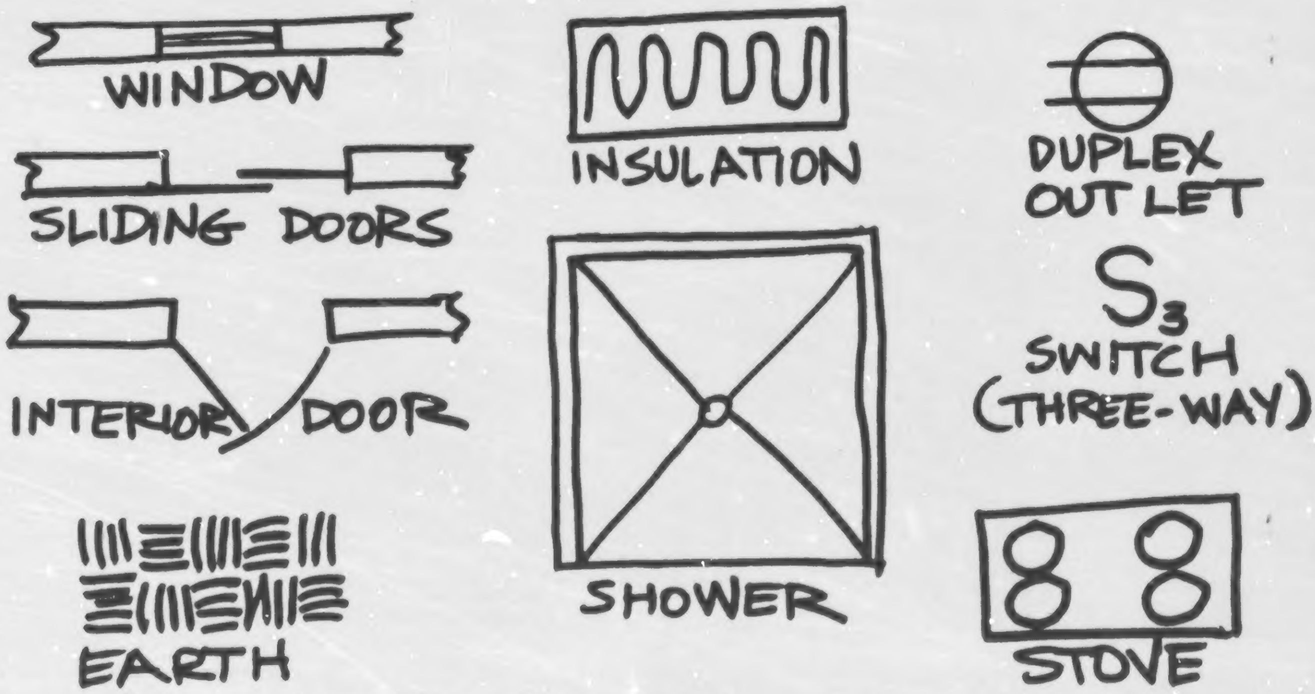
SCALE IN MILES

SYMBOLS USED ON ROAD MAPS

STANDARD DRAFTING SYMBOLS


WELD
ALL AROUND
FIELD WELD
FILLET WELD
THIS SIDE
BEVEL
BOTH SIDES

WELDING SYMBOLS


WINDOW
INSULATION
DUPLEX
OUTLET
SLIDING DOORS
S_3
SWITCH
(THREE-WAY)
INTERIOR DOOR
SHOWER
EARTH
STOVE

ARCHITECTURAL SYMBOLS

6 Representing Three-Dimensional Objects on Paper

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. describe ways in which industry uses drawings;
2. identify multiview drawings, working drawings, and orthographic projections;
3. identify two types of pictorial drawings;
4. draw multiview drawings of an object;
5. draw isometric drawings of an object; and
6. identify the two systems of dimensioning drawings.

KEY WORDS: VOCABULARY

The words listed below may be new to the student studying drafting. Teachers should help students understand these words as they are used in this topic of study.

height
depth
orthographic projections
oblique
aligned
width
multiview drawings
pictorial drawings
isometric
dimensions
unidirectional

TEACHING AIDS

- Overhead projector
- Models
- Drawing instruments for use on projector
- Chalkboard, chalk
- Test Key: 1-D, 2-B, 3-A, 4-C, 5-B, 6-B, 7-C, 8-A
- Transparencies: You will find transparency masters D6-1 through D6-8 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to the students while they are studying different aspects of this unit. An explanation of each transparency follows.

  D6-1: Height, Width, and Depth in Everyday Life; illustrates some of the objects that we see every day.
  D6-2: Multiview Drawing; shows how height, width, and depth are used in multiview drawings.
  D6-3: Multiview Drawing of a Machinist Square; provides an example of the use of this type of drawing as a working drawing.
  D6-4: Isometric Drawing; shows how isometric drawings are made.
  D6-5: Oblique Drawing; shows how an oblique drawing is made.
  D6-6: Pictorial; illustrates a bicycle rear hub assembly.
  D6-7: Pictorial; shows how these drawings are used in model car assembly.
  D6-8: The Two-Dimensioning Systems Used in Industry; illustrates both the unidirectional system and the aligned system.

SUGGESTED REFERENCES

Brown, W.C. Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982. (Student workbook available.)

Feirer, J.L., and Lindbeck, J.R. Basic Drafting. Peoria, Ill.: Charles A. Bennett Company, 1978. (Student workbook available.)

Groneman, C.H., and Feirer, J.L. General Industrial Education. New York: McGraw-Hill Book Company, 1979.

Miller, W.R., and Ross, S. Drafting. Bloomington, Ill.: McKnight Publishing Company, 1978.

Spence, W.P. Basic Industrial Drafting. Peoria, Ill.: Charles A. Bennett Company, 1979.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982. (Student workbook available.)

Walker, J.R. Exploring Metric Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1980. (Student workbook available.)

Wallach, P.I. The Basic Book of Drafting. Chicago: American Technical Society, 1979.

Yaslow, S. Elements of Mechanical Drafting. Albany, N.Y.: Delmar Publishers, 1979. (Student workbook available.)

SENTENCE OUTLINE

I. Describing the shape of an object (Transparency D6-1)
   A. The shape and size of almost all objects in our world can be described by their **height**, **width**, and **depth**. Each person sees objects every day that provide this information about

their shapes and sizes.

B. Look around you in the classroom, and you will see examples of shape and size. The door to the classroom provides visual information about its height and width. Closer examination will also reveal its depth. The walls of the room also have height and width. The light fixtures, switch plates, cabinets, chalkboards, tables, chairs, and desks all have distinct shapes that can be described using their height, width, and depth.

C. You will find similar examples in your home. Look at your television. If you look at the front, you will quickly see that it has a certain height and width. Now, if you move slightly to the right, you will be able to see the front and right side of the television. This view of the side gives you some idea of the depth of the TV set. You can also confirm the height of the set from this view of the right side. If you stand up a little more, you will be able to see the top of the set. This view of the TV helps you confirm the width and depth that you also see in the front and side view of the television.

D. Examine a box of cereal in a store. You should find that the front and bank panels are the same height as the side panels. The width of the front and back panels is the same as the width for the top and bottom panels. The side panels have the same depth as the top and bottom panels.

E. If you look at a friend of yours, you will see that he or she is the same height regardless of whether you are looking at your friend from the front, back, left, or right side. The distance from one shoulder remains the same whether you look at the person from the front or back. This distance remains the same even when viewed from above the person.

F. A physical object can be manipulated so that the viewer can see what each side looks like. This can be done by walking around the object or by picking it up and rotating it. Objects that are drawn must be put together in the mind of an individual. A person looking at a drawing must be able to put all the views together and create a mental image of the object. This process becomes easier the more you work with drawings.

G. As a drafter, you will have to make drawings of objects that accurately represent their shapes and sizes. You will have to learn how to describe an object by drawing it on a flat surface. To make drawings, you need to learn and to use standard drafting procedures to communicate ideas to others.

H. You should be familiar with two types of drawings. One is the multiview drawing or orthographic projection, and the other is the pictorial drawing.

II. Multiview drawings (Trans. D6-2 and D6-3)

A. **Multiview drawings** (also called **orthographic projections**) are the most common type of drawing used to show how products are made. Multiview drawings are also called working drawings. They get their name because they show several views of the same object. The most common views used throughout industry are the top, front, and right sides.

B. Although working drawings prepared in industry normally provide the top, front, and right side views of an object, there may be some exceptions that require more or fewer views.

C. As a drafter, you may draw only one part of a machine, or you may draw several different parts. Think of all the different parts of a bicycle. Before it is manufactured, a working drawing must be made of each part.

D. If you worked in the aerospace industry, you might be assigned the task of making drawings for several parts of a missile, rocket, or airplane. You might have to make 10 or 20 drawings of one switch to show all of its components. However, each drawing is necessary for the workers who make the switch components.

E. The hydraulic system used in airplanes is made up of many valves, switches, tubes, hoses, and coupling devices. Each part must be drawn so that a worker can make the part and all its components. The hydraulic system alone may consist of hundreds of drawings.

F. An automobile consists of many

assembled parts that work together to make a complete functioning automobile. Each of these parts must be designed and drawn so it can be mass-produced.

G. The automobile industry uses computers in drafting and designing vehicles. These computers enable many changes to be made very quickly to initial design ideas.

H. Many companies contract with other businesses to make specific product parts or components. These contractors need detailed working drawings so they can make the required item. All drawings must be coordinated so that the entire product can be assembled correctly. Many parts of components may be manufactured in one geographical location and shipped to another geographical region to be assembled.

I. Examine the many pieces of equipment and furniture in your classroom to see how many different parts they contain. How can a worker make the different parts of a desk if there are no drawings to show shape, size, and dimensions?

III. Pictorials

A. **Pictorial drawings** show objects as they would appear in a photograph or as you would see them with your eye. Pictorial drawings are often used to show how products are assembled. There are two types of pictorials that drafters in industry should be able to draw. These are **isometrics** and **obliques.** (Trans. D6-4 and D6-5)

B. Pictorials are used in industry to show workers how each part or component is assembled to make the finished product. A pictorial can also show what the finished product looks like.

C. Many catalogs and brochures that advertise products use pictorials. These drawings help customers visualize the product and its components.

D. Technical representatives use illustrated company manuals to assist their customers. These representatives assist in setting up and servicing specialized equipment. They also assist in training employees in the operation and maintenance of equipment. Pictorial drawings enable technical representatives to communicate easily with individuals who are not familiar with the products and equipment.

E. Individuals who work in repair and service occupations must rely on pictorial drawings and written instructions to replace worn or defective parts. Automobile mechanics use service manuals to help them as they repair automobiles. Appliance repairers must use manuals that describe how to repair defective parts. All of these individuals are aided in their work by the pictorial drawings in service and repair manuals. (Trans. D6-6)

F. Consumers also use pictorial drawings provided by manufacturers. Many products can be bought unassembled. The consumer assembles these products at home by following the instructions provided by the manufacturer.

G. Some furniture items and toys can be bought cheaper if they are assembled by the consumer. Complete instructions are provided for assembly, including pictorial drawings of the item. Many small repair jobs around the home can be completed by the occupant by following the directions that accompany the replacement parts. These directions normally include a pictorial drawing of the assembly procedure.

H. Individuals who do repair work on their cars, trucks, or other vehicles can purchase repair manuals that provide information for completing repairs and service. These manuals are generally illustrated with pictorial drawings that clarify written instructions.

I. Many young people assemble models by following the manufacturer's instructions. These instructions include pictorials that help individuals successfully assemble the model. Pictorials clarify the written instructions. Sometimes individuals just look at the picture to assemble the model rather than read the instructions. (Trans. D6-7)

J. Textbooks that you use in the classroom contain many pictorial drawings. These drawings are provided to help you clarify the written information.

IV. Dimensioning drawings

A. Even though an object is drawn to scale, it must also be dimensioned.

Dimensions show the actual measurements of an object. By placing the dimensions on the drawing, time and money are not wasted by having to measure each individual line on the drawing. Also, costly mistakes can be avoided if the drawing has been distorted during the reproduction stage. (Use Trans. D6-8)

B. Two systems are used for dimensioning. These are **aligned** and **unidirectional.** Drawings that use the aligned system have the dimensions placed on the drawings so they are read from the bottom and right side. Drawings that use the unidirectional system have all dimensions placed on the drawings so they are read from the bottom of the page.

C. Dimensions should be placed on the view that shows the best shape. These measurements must be legible and accurate.

D. Either the English or metric system of measurement can be used to show dimensions. However, the two should not be mixed if at all possible.

MATERIALS FOR STUDENTS

- Vocabulary Worksheet
- Student Worksheets 1, 2, 3, 4, 5, 6, 7, and 8
- Magazines, service and repair manuals, catalogs
- Poster board, glue
- Paper for drawing
- Drafting instruments
- Pencils
- Other materials that can be used for reinforcing the concepts presented in this unit

SUGGESTED STUDENT ACTIVITIES

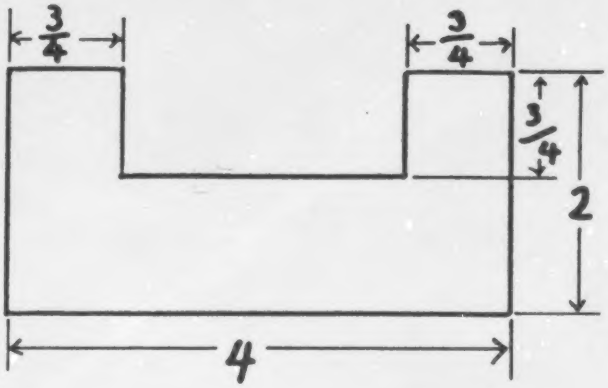
1. Have students search catalogs, magazines, service and repair manuals, and instruction sheets to find different types of drawings. Help the students group the drawings according to type. Divide the students into groups and have them develop a bulletin board display that illustrates the ways drawings are used in industry.
2. Use Student Worksheets 1 and 2. Have each student draw the flat-surfaced object to full size on a sheet of 8-1/2 x 11 in. paper. Each drawing should be neat and clean. Other drawings that you deem appropriate may be substituted for these.
3. Use Student Worksheets 3 and 4. Have each student make a multiview drawing from each of the pictorials on each worksheet. You may decide to use only selected problems from each worksheet and assign other problems that you deem necessary. Student Worksheet 5 may be used with advanced students. Each drawing should be correctly positioned on the paper. You may want to add dimensioning to this activity. If so, have the students correctly dimension each problem. Keep in mind that Student Worksheet 8 has been designed to teach dimensioning.
4. Use Student Worksheets 6 and 7. Have each student make an isometric or oblique drawing from the multiview drawings on each worksheet. You may decide to use only selected problems from each worksheet and assign other problems that you deem necessary. Students with greater ability may require supplemental problems that challenge them. Slower students may not be able to complete all of the problems on these worksheets. Feel free to supplement these activities with other activities that accommodate your students' needs.
5. Use the worksheets from Exploring Drafting student workbook and have each student complete the missing view of the multiview drawings. After they have completed the three views, you may want to have them make an isometric drawing of the same object.
6. Use Student Worksheet 8. Have each student dimension each of the problems presented on this worksheet. Each problem should be drawn and correctly dimensioned on a separate sheet of paper.
7. Have students make all the necessary drawings of an item they would like to make. These drawings should include dimensions. They should complete multiview and isometric drawings. This activity can be used best in conjunction with a general shop. There students will have the opportunity, after they have drawn plans, to make the item.
8. Have the students work in groups to design a product that could be produced in the industrial arts program. They must make all the necessary working drawings for someone to make the item. Include multiview and isometric drawings. This activity can be used with manufacturing classes.

Vocabulary Worksheet

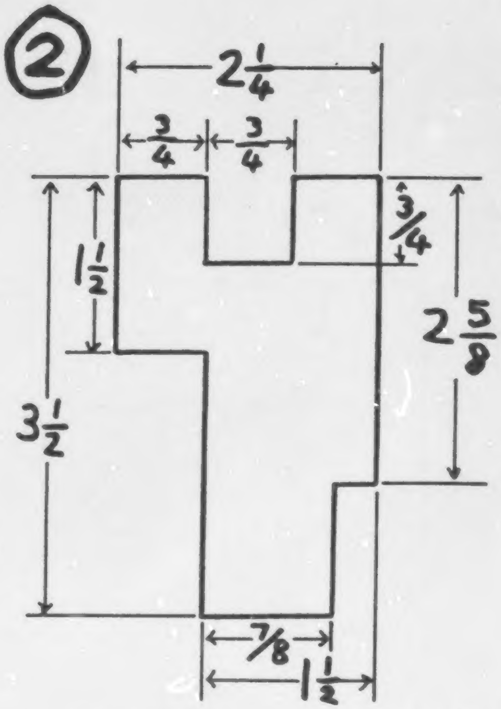
1. height
2. width
3. depth
4. multiview drawings
5. orthographic projections
6. pictorial drawings
7. isometric
8. oblique
9. dimensions
10. aligned
11. unidirectional

STUDENT WORKSHEET 1

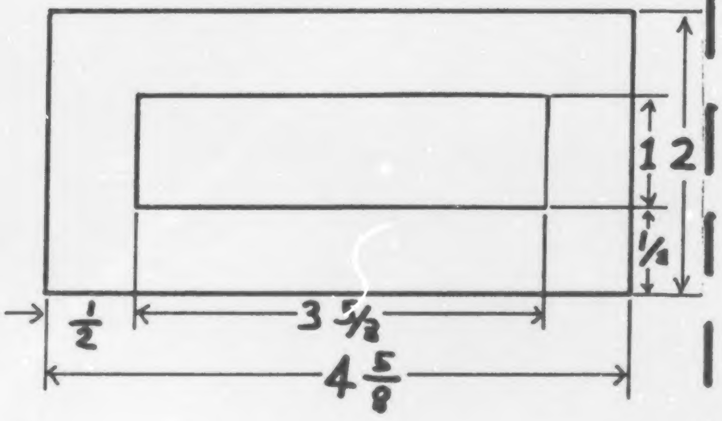
①



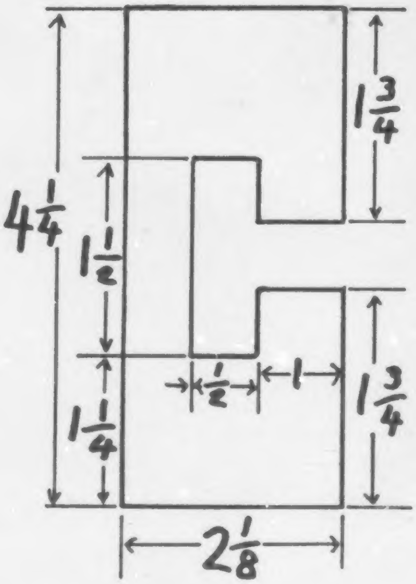
②


2 1/4
3/4
3/4
1 1/2
3/4
2 5/8
3 1/2
7/8
1 1/2

③

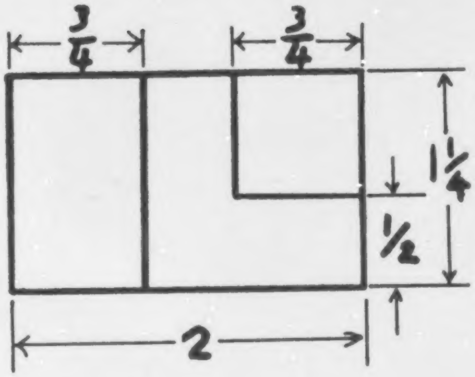

1
2
1/4
1/2
3 5/8
4 5/8

④

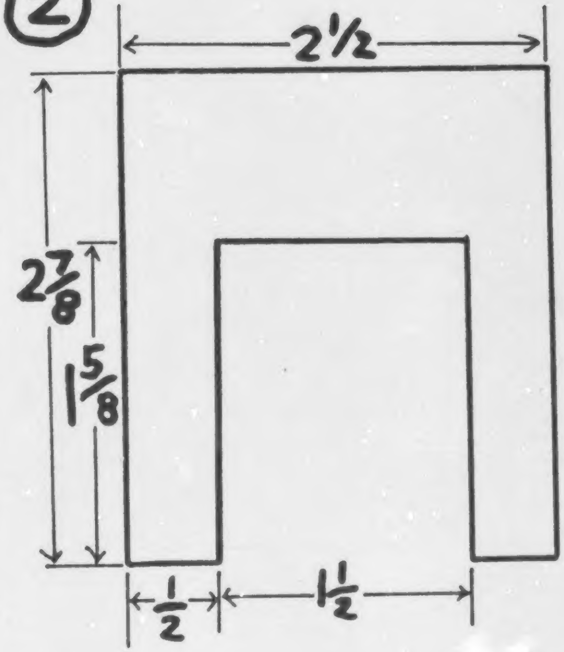

4 1/4
1 3/4
1 1/2
1 1/4
1/2
1
1 3/4
2 1/8

STUDENT WORKSHEET 2

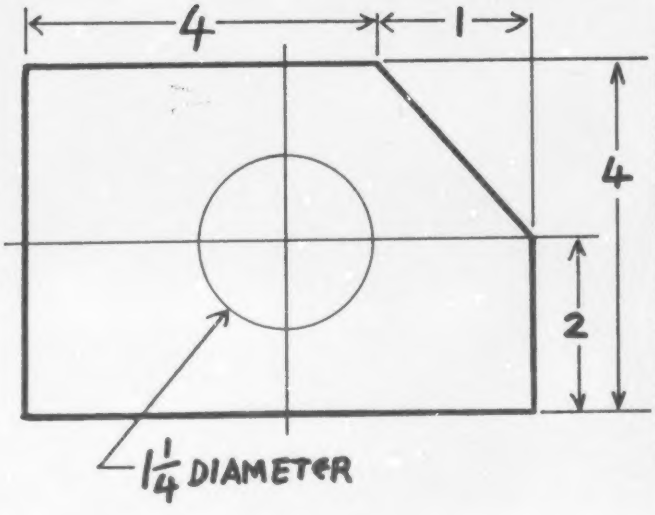
①


3/4
3/4
1 1/4
1/2
2

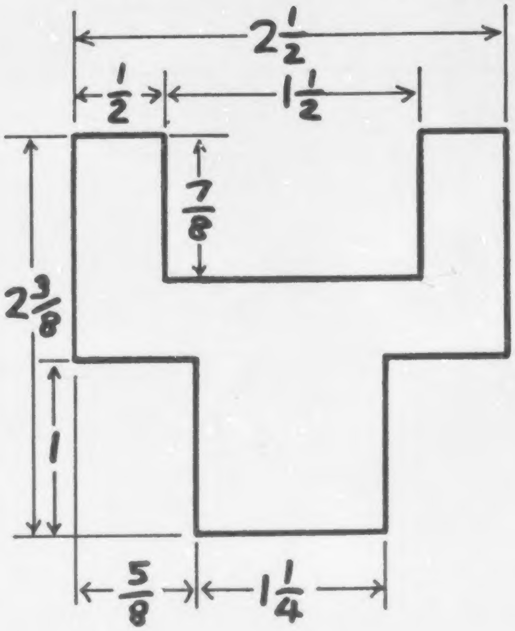
②


2 1/2
2 7/8
1 5/8
1/2
1 1/2

③

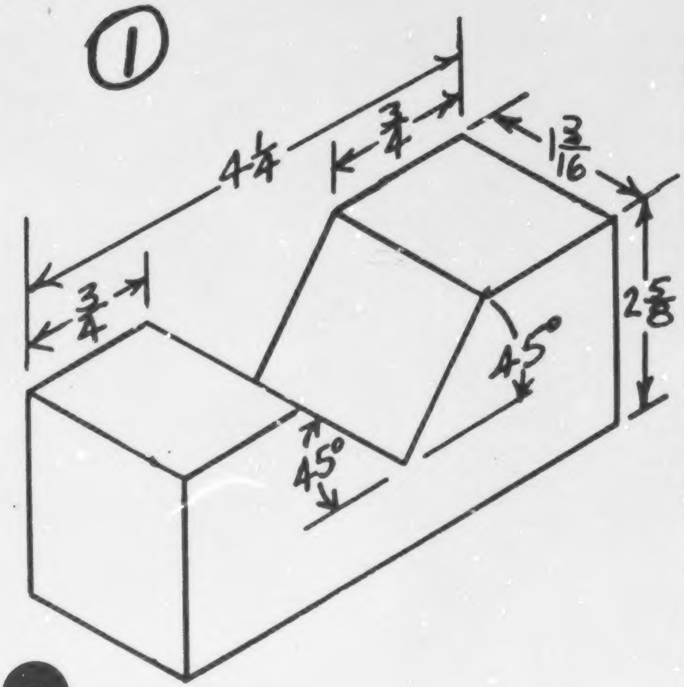

4
1
4
2
1 1/4 DIAMETER

④

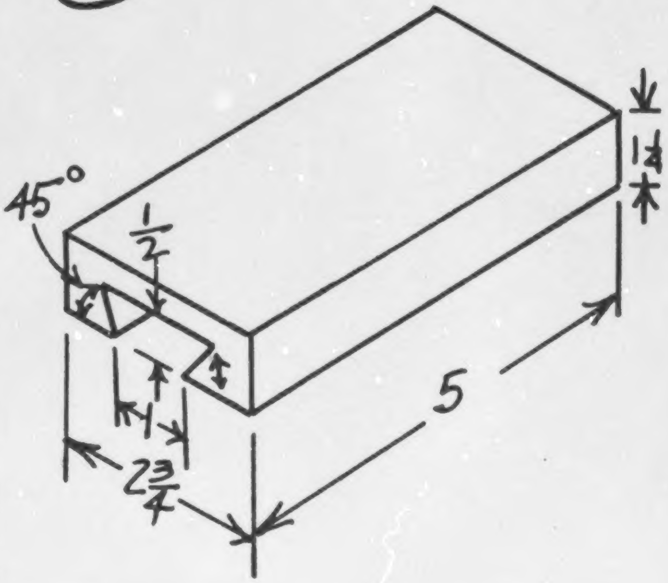

2 1/2
1/2
1 1/2
7/8
2 3/8
1
5/8
1 1/4

STUDENT WORKSHEET 3

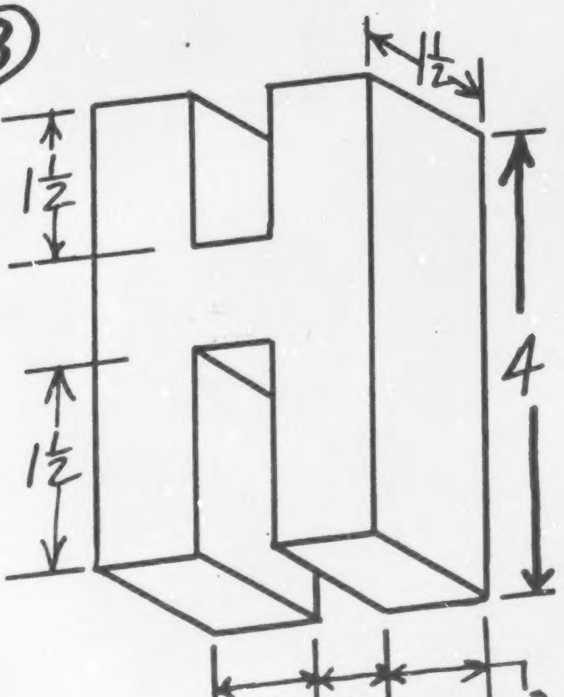
①


4 1/4
3/4
1 3/16
2 5/8
3/4
45°
45°
45°

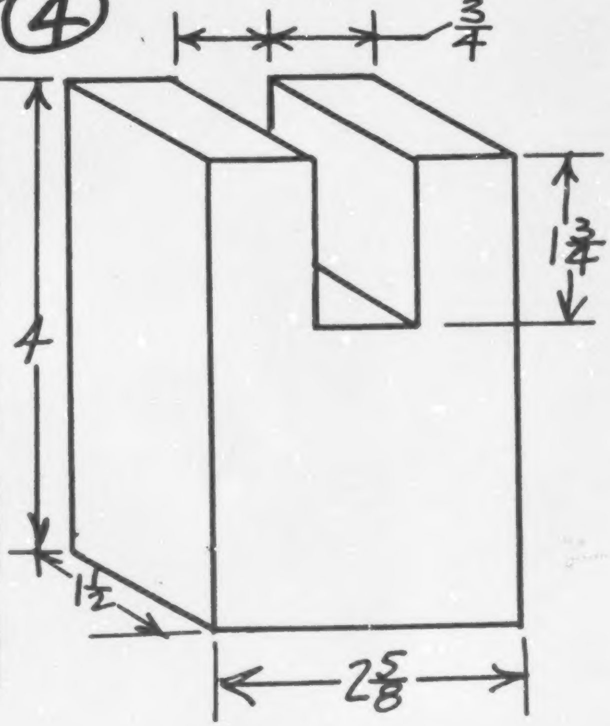
②


45°
1/2
1/4
1/4
1
2 3/4
5
1/4

③

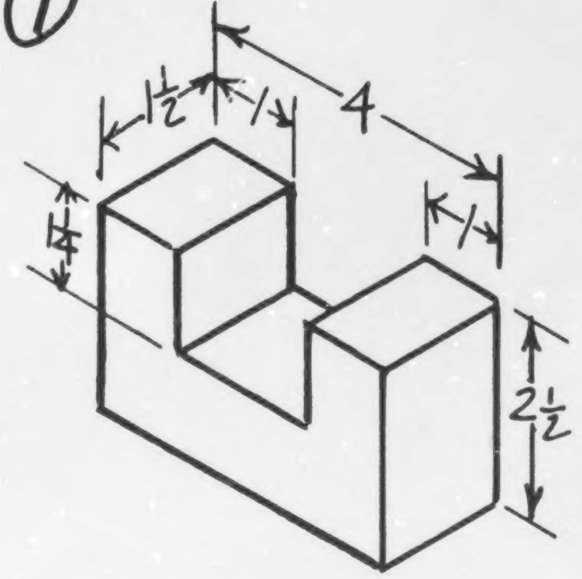

1/2
1 1/2
1 1/2
4
3/4
1/2
3/4

④

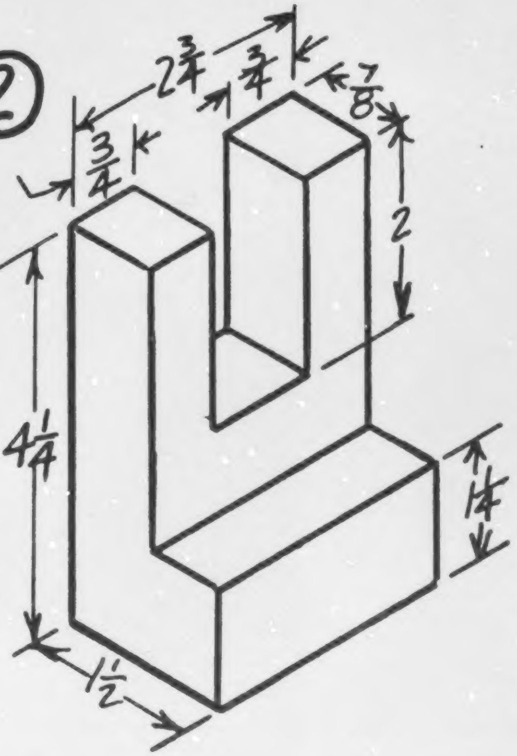

3/4
1 3/4
4
1 1/2
2 5/8

STUDENT WORKSHEET 4

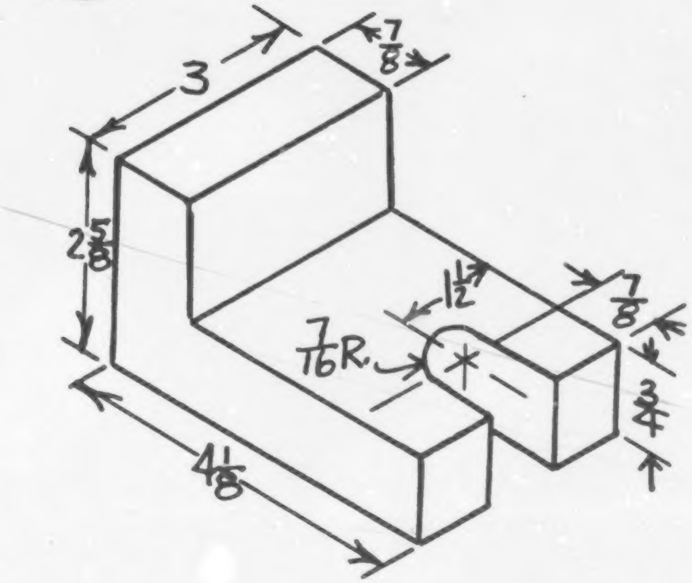
①



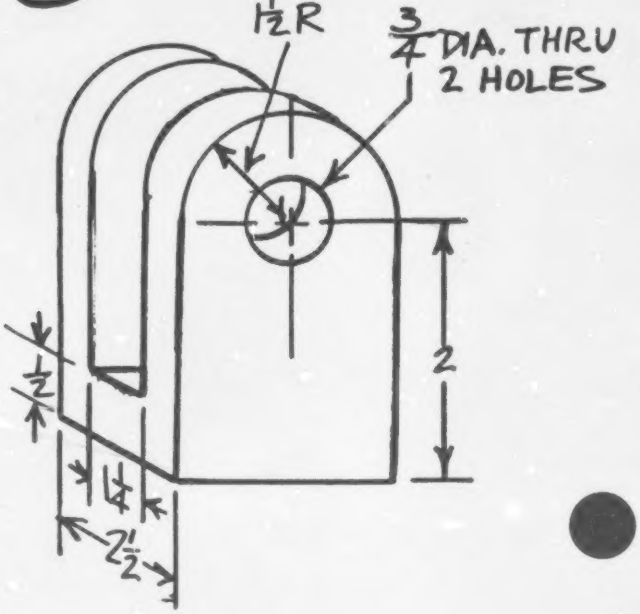
②


2¾
¾
7/8
¾
2
4¼
1¼
1½

③

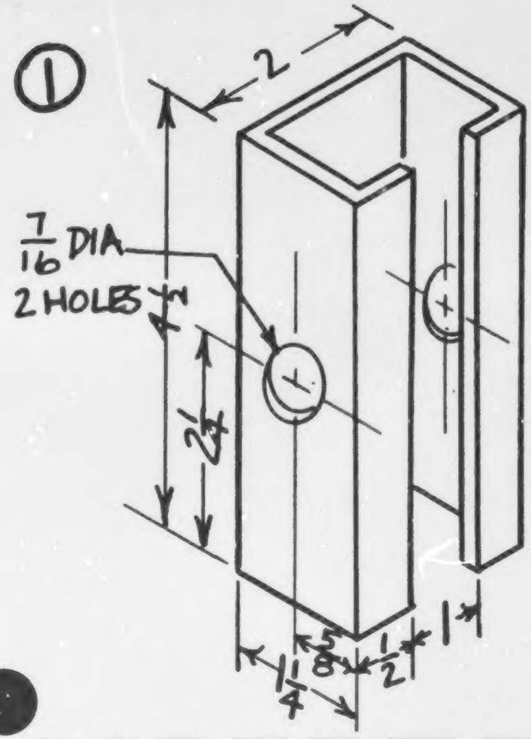

3
7/8
2 5/8
1½
7/8
7/16 R.
¾
4 1/8

④

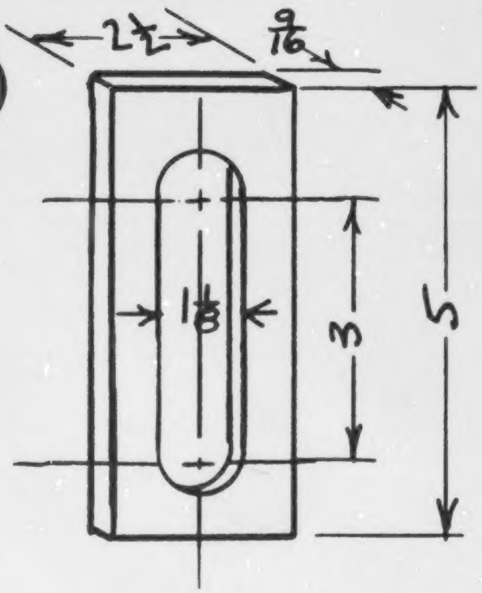

1½ R
¾ DIA. THRU
2 HOLES
½
2
1¼
2½

STUDENT WORKSHEET 5

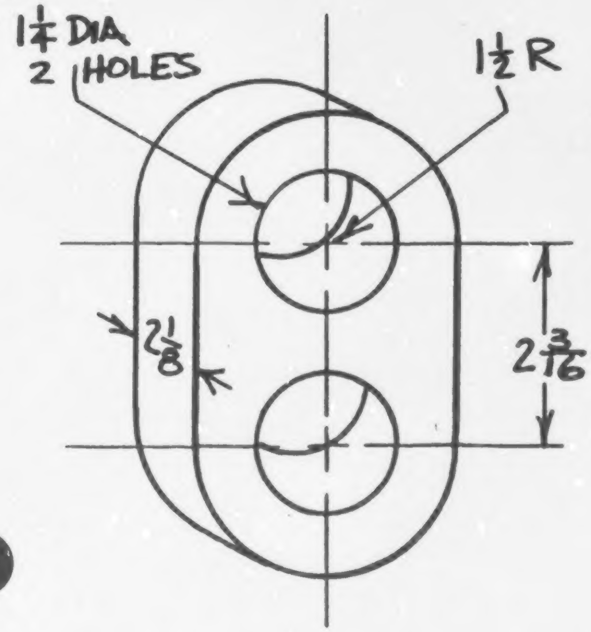
①


2
7/16 DIA
2 HOLES
4
2 1/4
5/8
1 1/4
1/2
1

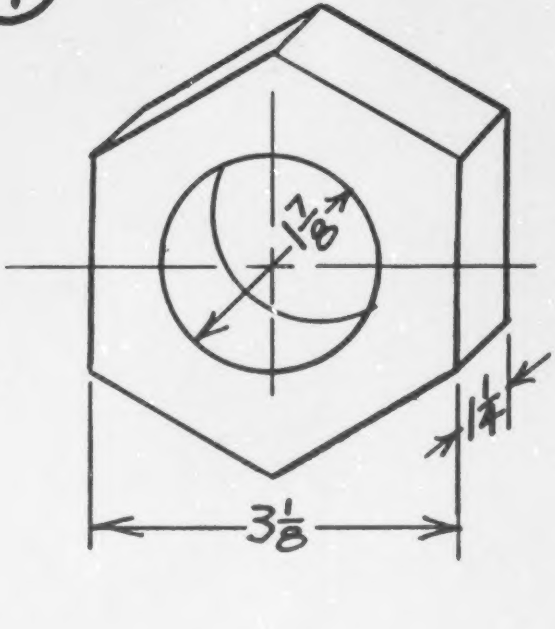
②


2 1/2
9/16
1 1/8
3
5

③

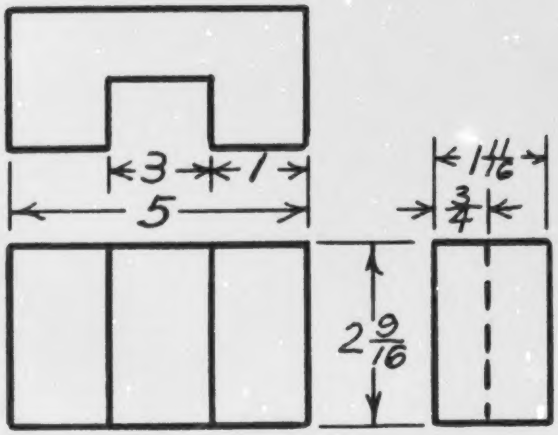

1 1/4 DIA
2 HOLES
1 1/2 R
2 1/8
2 3/16

④

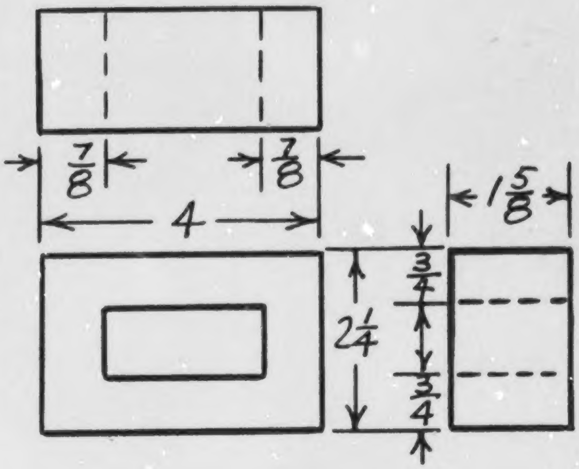


STUDENT WORKSHEET 6

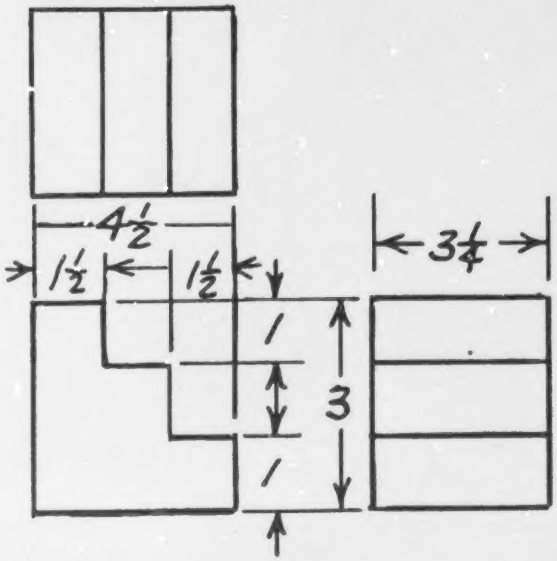
①


3
1
5
1 11/16
3/4
2 9/16

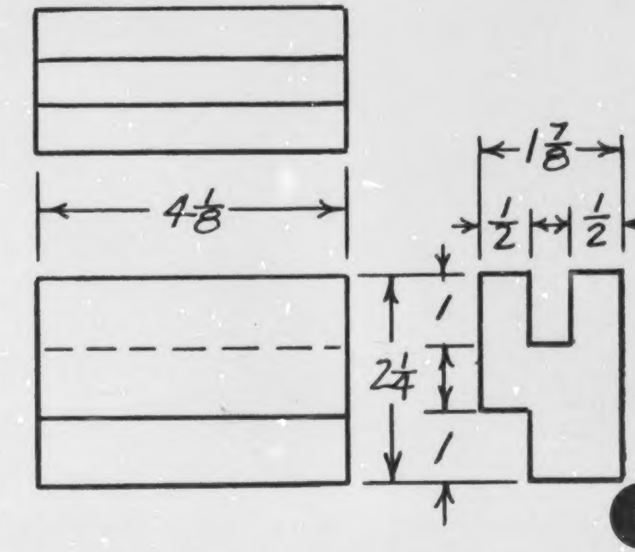
②


7/8
7/8
4
1 5/8
3/4
2 1/4
3/4

③

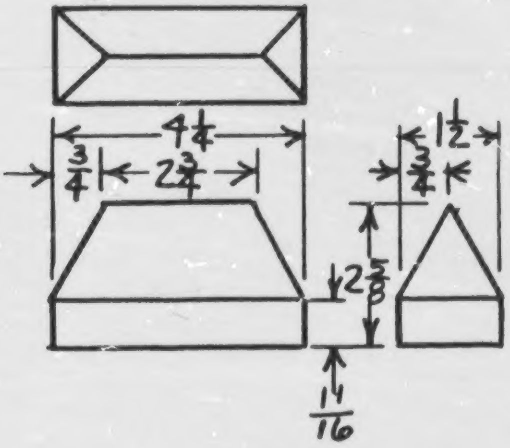

4 1/2
1 1/2
1 1/2
3 1/4
1
3
1

④

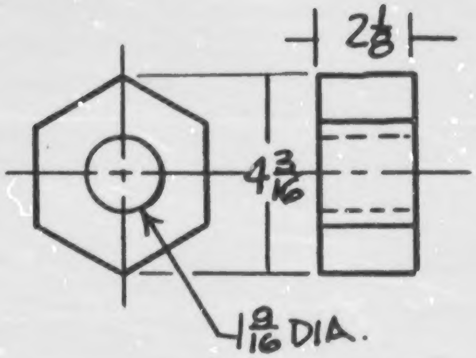

4 1/8
1 7/8
1/2
1/2
1
2 1/4
1

STUDENT WORKSHEET 7

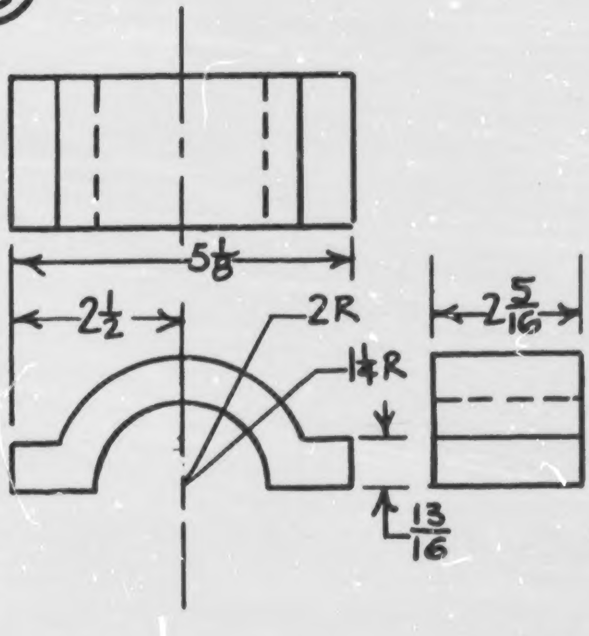
①


4 1/4
3/4
2 3/4
1 1/2
3/4
2 5/8
14/16

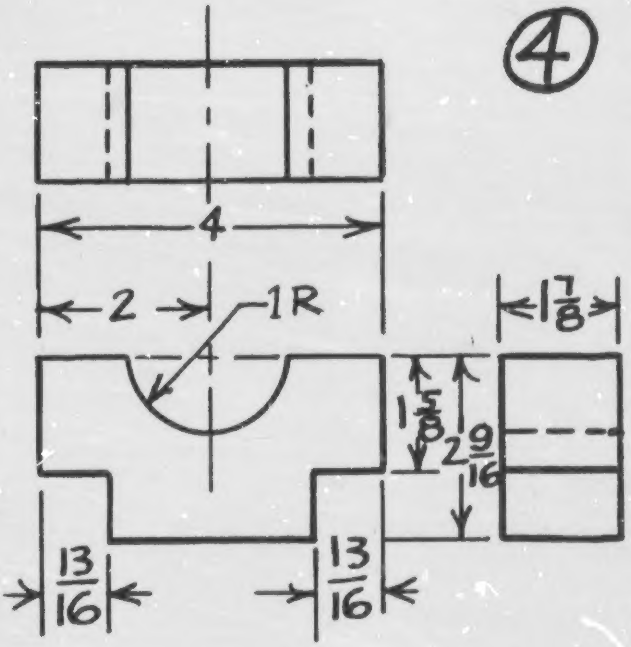
②


2 1/8
4 3/16
1 9/16 DIA.

③


5 1/8
2 1/2
2R
1 1/4 R
2 5/16
13/16

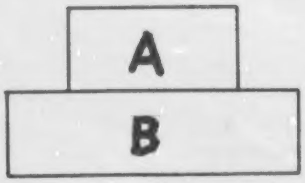
④


4
2
1R
1 7/8
1 5/8
2 9/16
13/16
13/16

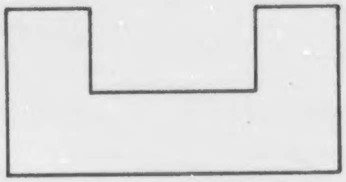
STUDENT WORKSHEET 8

DIRECTIONS: Draw and dimension each of the objects shown below.

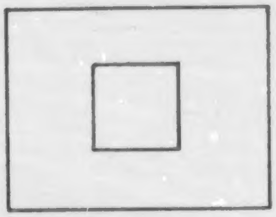
This block is 2 1/2" x 1 1/4".



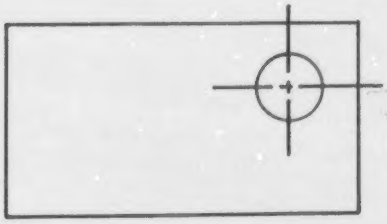
Rectangle A is 1 3/4" x 3/4".
Rectangle B is 2 7/8" x 3/4".



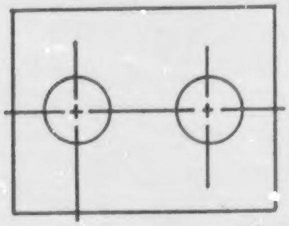
This block is 3 inches long and 1 1/2 inches high. The slot is 2 inches long and 3/4 inch high.



This block is 3 1/4 inches long and 2 3/4 inches high. The small square is centered on the block and is 1" x 1".



This block is 3 1/2 inches long and 1 3/4 inches high. The hole is 5/8 inch in diameter. The center is located 1 inch from the top and right end.



This block is 2 5/8 inches long and 2 inches high. Both holes are 1/2 inch in diameter. The center of each hole is 1 inch from the top and 3/4 inch from the ends.

TEST

Unit 6: Representing Three-Dimensional Objects on Paper

Directions: Read each statement carefully. Select the one word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank.

Example: __C__ 21. The class you are now attending is—

A. American Government
B. Language Arts
C. Industrial Arts
D. General Science

___ 1. The shape of almost all objects can be described by its—

A. width, length, and thickness
B. width, strength, and thickness
C. length, size, and height
D. depth, height, and width

___ 2. Two types of drawings that all drafters must be familiar with are—

A. multiple copy and pictorial
B. multiview and pictorial
C. miniview and projection
D. multiview and projection

___ 3. Drawings made by orthographic projection are also called—

A. multiview drawings
B. pictorial drawings
C. perspectives
D. miniview drawings

___ 4. Working drawings are the same as —

A. multiview and pictorials
B. sections and details
C. multiview and orthographic
D. multiview and orthoglyphic

___ 5. The most common views presented on multiview drawings are—

A. top, back, and left side
B. top, front, and right side
C. top, bottom, and front
D. bottom, back, and right side

___ 6. Drawings that show an object as it would appear in a photograph or as you would see it with your eye are—

A. projections
B. pictorials
C. profiles
D. cross sections

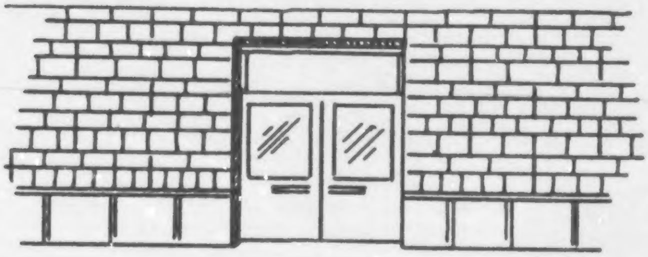
___ 7. Isometric and oblique drawings are both—

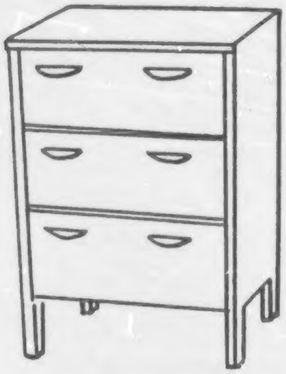
A. working drawings
B. multiview drawings
C. pictorial drawings
D. cross sections

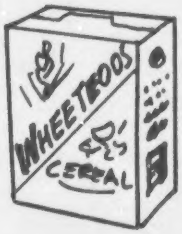
___ 8. The two systems for dimensioning drawings are—

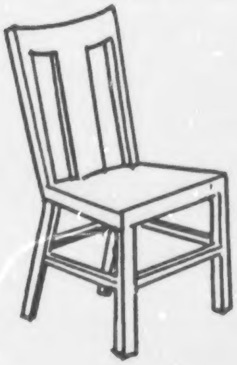
A. unidirectional and aligned
B. unidirectional and lines
C. lined and aligned
D. unidirectional and omnidirectional

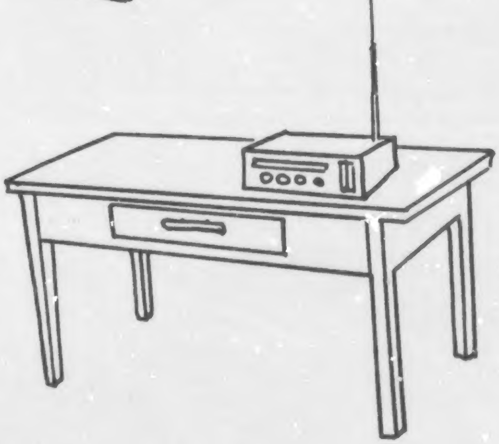
HEIGHT, WIDTH, AND DEPTH IN EVERYDAY LIFE



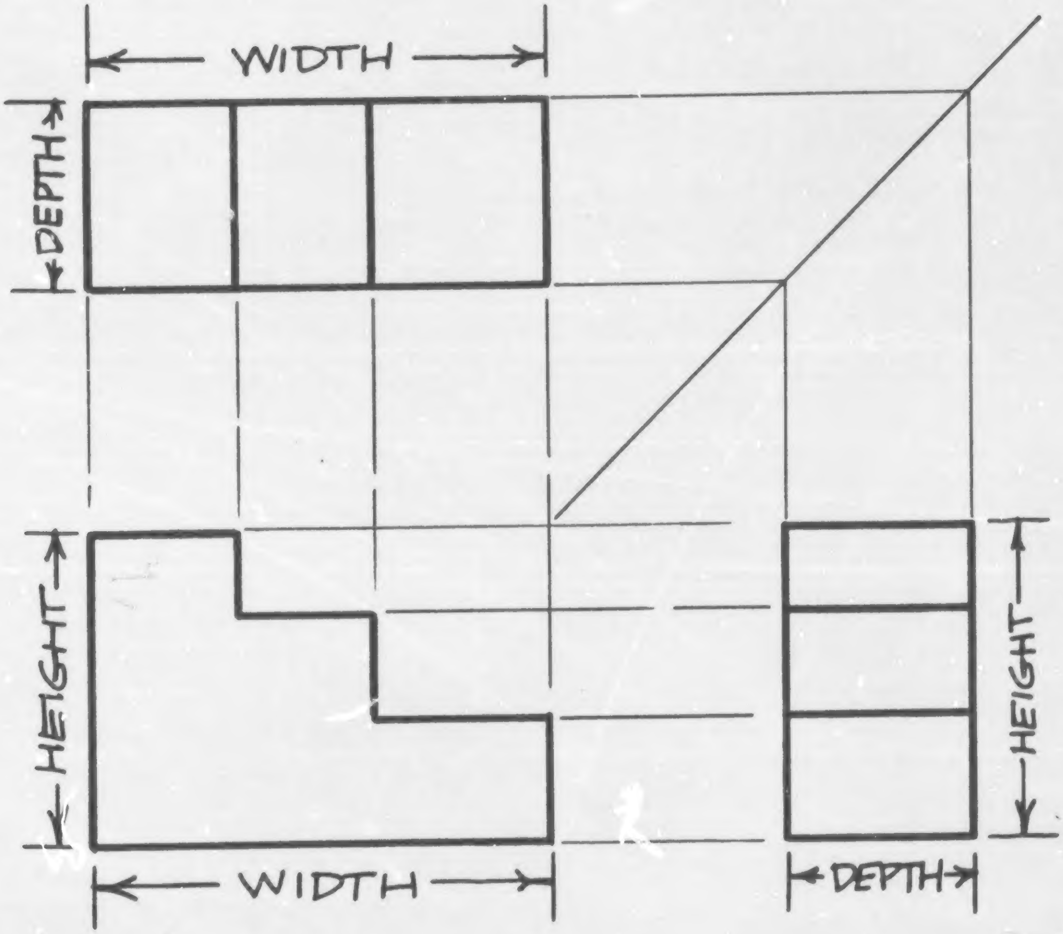



WHEETEROOS
CEREAL



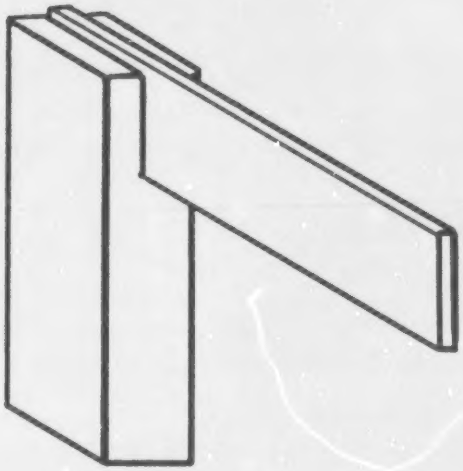


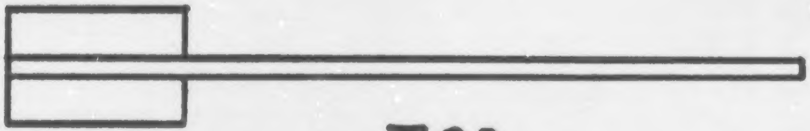
MULTIVIEW DRAWING


WIDTH
DEPTH
HEIGHT
WIDTH
HEIGHT
DEPTH

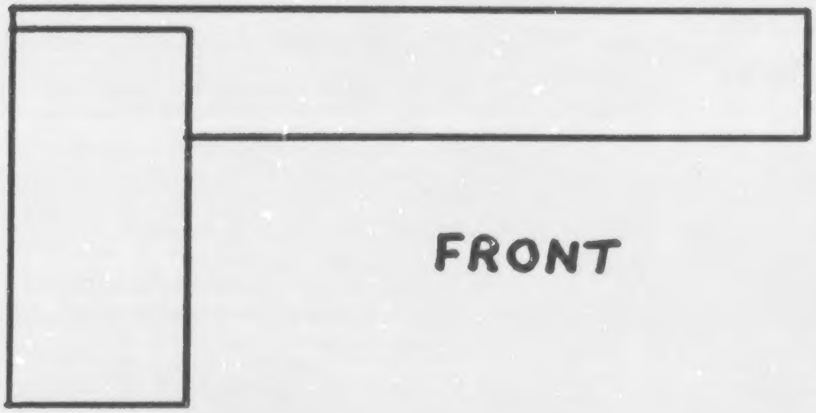
D6-2

MULTIVIEW DRAWING OF A MACHINIST SQUARE

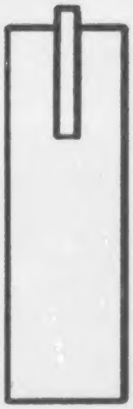




TOP

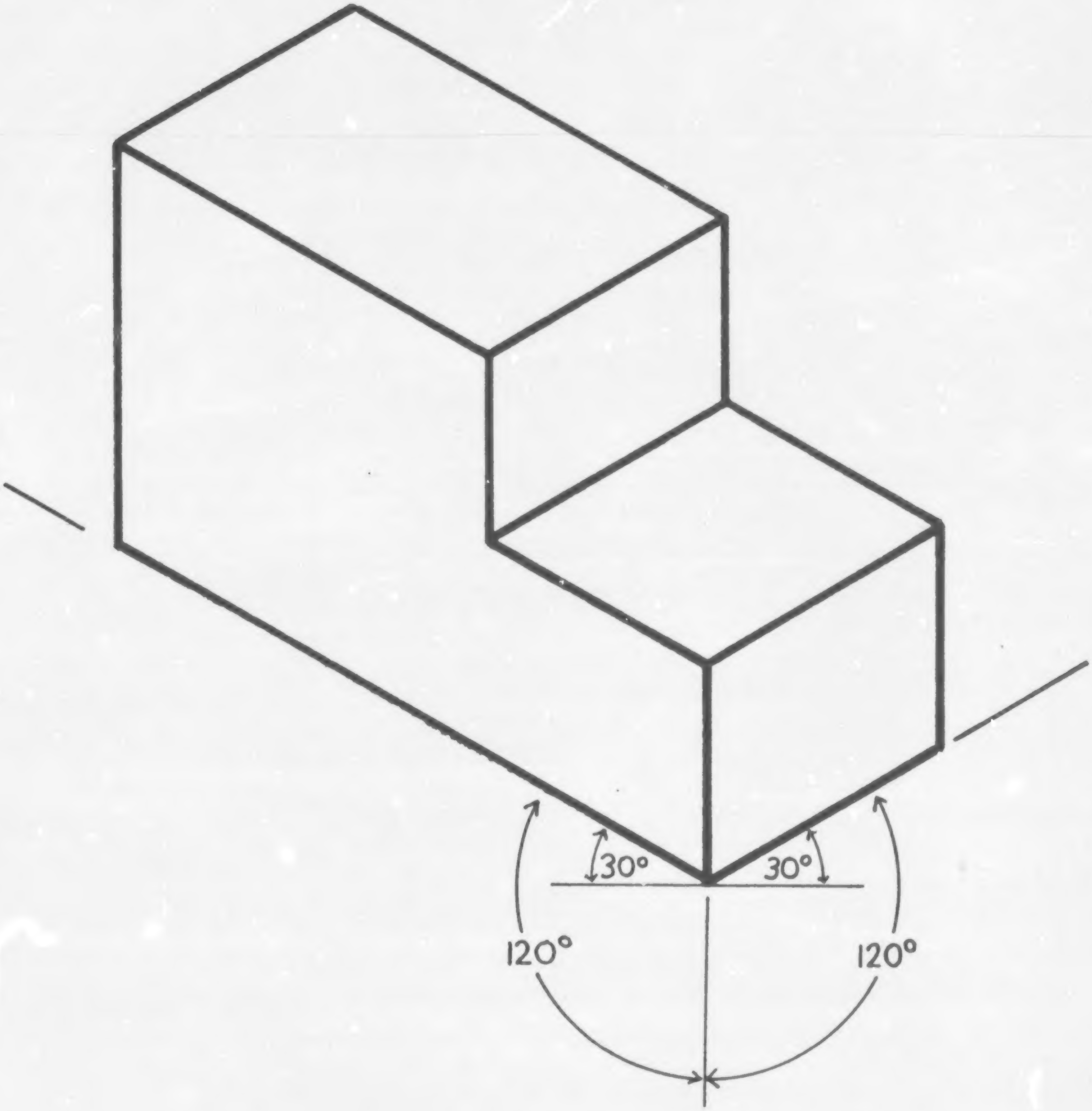


FRONT

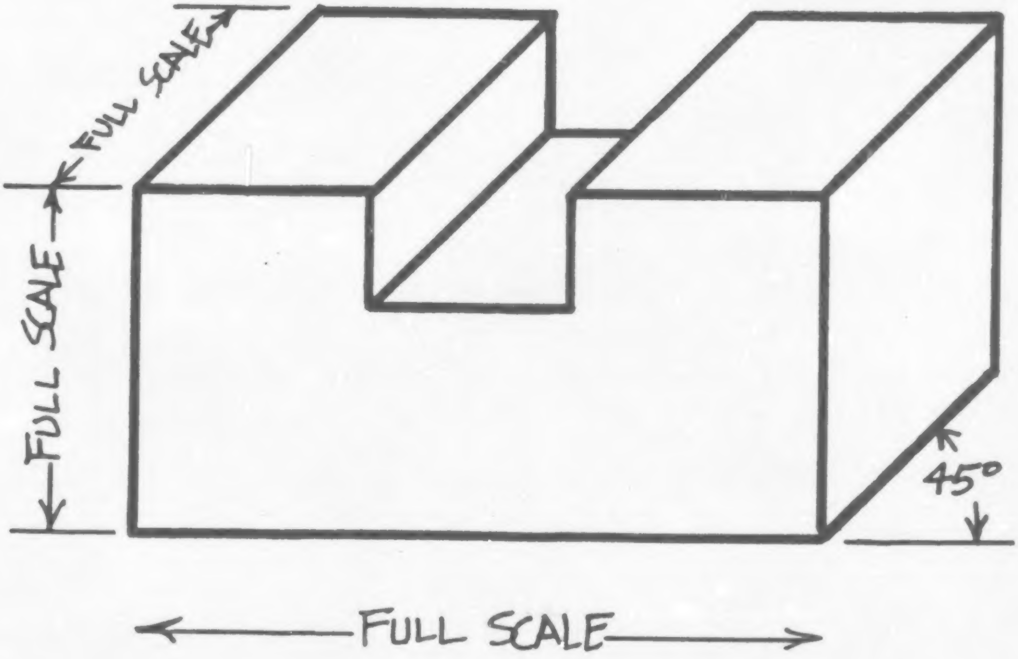


RIGHT SIDE

ISOMETRIC DRAWING

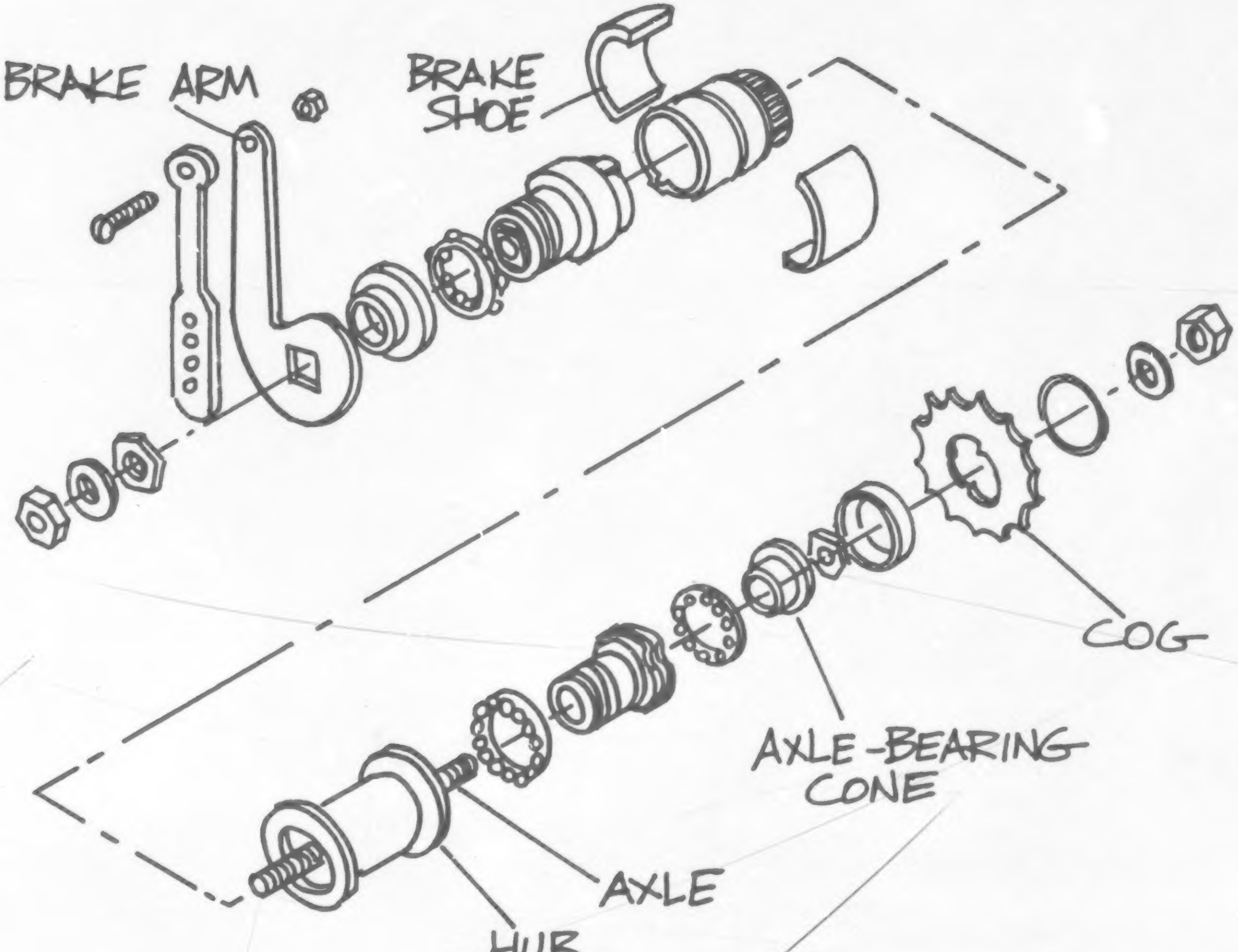

30°
30°
120°
120°

OBLIQUE DRAWING
(CAVALIER)

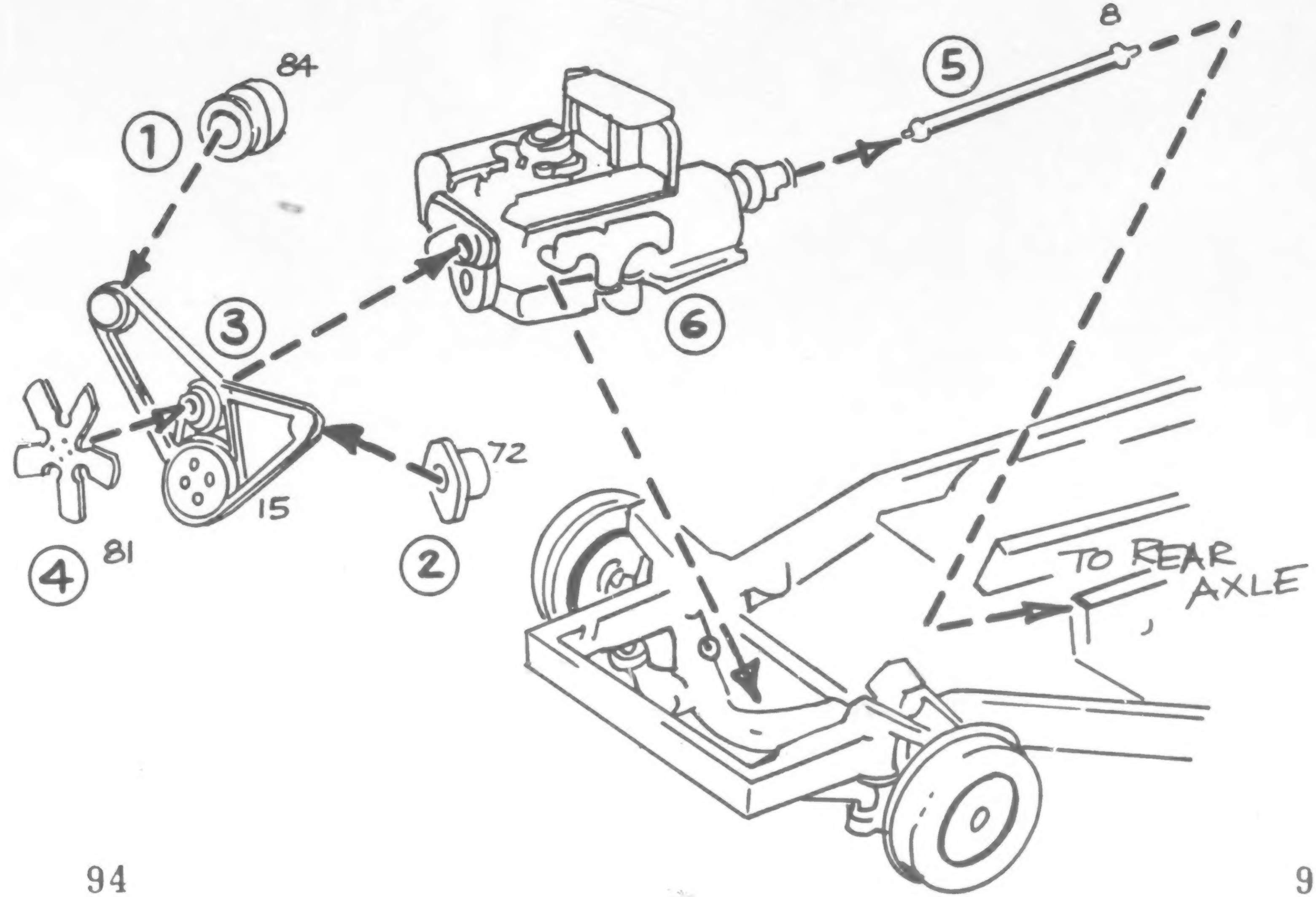

FULL SCALE
FULL SCALE
45°
FULL SCALE

PICTORIAL
BICYCLE REAR HUB ASSEMBLY

D6-6

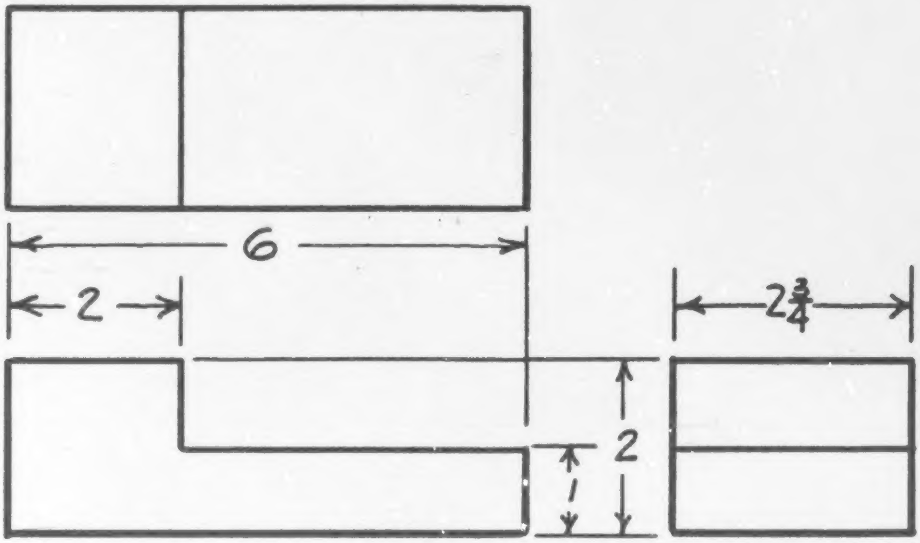

BRAKE ARM
BRAKE SHOE
COG
AXLE-BEARING CONE
AXLE
HUB

PICTORIAL
MODEL CAR ASSEMBLY

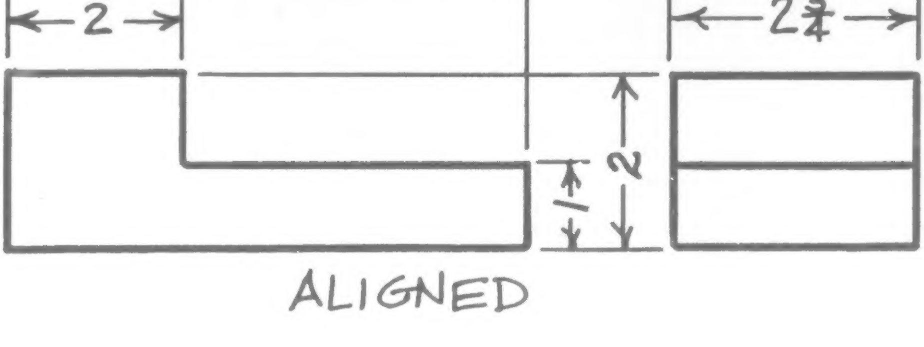

84
①
8
⑤
③
⑥
④
81
15
72
②
TO REAR AXLE

D6-7

THE TWO DIMENSIONING SYSTEMS USED IN INDUSTRY



UNIDIRECTIONAL



ALIGNED

7 Occupational Information About Drafting Careers

OBJECTIVES

After students have covered the material in this unit, they should be able to—

1. identify several drafting occupations in industry; and
2. identify several other occupations that require the use of drafting skills and knowledge.

KEY WORDS: VOCABULARY

The words listed below may be new to the student studying drafting. Teachers should help students understand these words as they are used in this topic of study.

- marine architect
- detailer
- tool designer
- design checker
- marine drafter
- mechanical drafter
- architect
- technical illustrator
- landscape architect
- chief drafter
- civil drafter
- electronic drafter
- industrial designer
- drafting checker

TEACHING AIDS

- Overhead projector
- Newspapers (want ads)
- Brochures and pamphlets about careers (These materials can sometimes be obtained from employment agencies, union offices, industries, and professional organizations.)
- Selected filmstrips from "Fascinating World of Work Career Awareness Series," National Career Consultants, Inc., 1300 E. Arapaho Rd., Richardson, Texas 75081
- Test Key: 1-B, 2-C, 3-A, 4-D, 5-B, 6-B, 7-A, 8-C, 9-B, 10-D
- Transparencies: You will find transparency masters D7-1 and D7-2 at the end of this unit. If you wish, these masters may be duplicated in quantity and given as handouts to the students while they are studying different aspects of this unit. An explanation of each transparency follows.

D7-1: Some Drafting Occupations; shows some of the occupations that individuals interested in drafting might pursue.

D7-2: Occupations Which Use Drafting Skills and Knowledge; shows some of the occupations that require workers to have some basic skills and knowledge of drafting.

SUGGESTED REFERENCES

Groneman, C.H., and Feirer, J.L. General Industrial Education. New York: McGraw-Hill Book Company, 1979.

Miller, W.R., and Ross, S. Drafting. Bloomington, Ill.: McKnight Publishing Company, 1978.

Occupational Outlook Handbook. Bulletin 2075, 1980-81 edition. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics, 1980.

Spence, W.P. Basic Industrial Drafting. Peoria, Ill.: Charles A. Bennett Company, 1979.

Walker, J.R. Exploring Drafting. South Holland, Ill.: The Goodheart-Willcox Company, 1982.

SENTENCE OUTLINE

NOTE: The occupations listed in this unit are not all-inclusive. They are, however, a relative sample of those found in the drafting field. More than likely, teachers and students will be able to identify many drafting-related occupations not covered in this unit. You may want to integrate occupational information throughout this topic of study rather than teach it as a separate unit.

I. Drafting as a career
  A. Many individuals work in occupations that require the daily use of drafting tools and equipment to produce drawings. Many of these individuals work in specialized areas of drafting, such as electronics drafting, automotive styling, aerospace, marine and other types of architecture, and engineering.
  B. Individuals work their way up from positions as drafting trainees or detailers to checkers or chief drafter.
  C. Many individuals, who are not drafters, work in occupations that require some knowledge and skills of drafting.

II. Occupations that utilize drafting skills and knowledge (Use Transparencies D7-1 and 2)

A. A **marine architect** designs the complete hull and superstructure of boats and ships. These designs must conform to specifications and test dates, and standards of safety, efficiency, and economy. Marine architects consult with engineers and other architects to lay out the interior design of vessels so they accommodate passengers, elevators, cargo compartments, heating and ventilating systems, refrigeration equipment, engine components, and other necessary equipment.

B. A **detailer** makes detailed drawings of parts of machines and structures from rough or general design drawings. This worker must make detailed drawings as clearly and completely as possible by including dimensions, materials used, and any other information necessary to produce the item drawn. Detailers may also make tracings of finished drawings from which blueprints can be made.

C. **Technical illustrators** lay out and draw illustrations for reproduction in reference books, brochures, and technical manuals dealing with assembly, installation, operation, maintenance, and repair of machines, tools, and equipment. These workers prepare illustrations from drawings, mock-ups, and photographs.

D. **Landscape architects** plan and design the development of land areas for projects such as parks and recreational facilities, airports, highways, parkways, hospitals, schools, residential subdivisions, and commercial and industrial sites. Landscape architects compile and analyze data on site conditions that relate to soil, vegetation, rock features, drainage, and location of structures. These individuals prepare site plans, working drawings, specifications, and cost estimates for development of land sites.

E. **Tool designers** design broaches, milling machine cutters, drills, and other cutting tools and related jigs, dies, and fixtures for production or experimental use in metalworking machines. These designers must make preliminary sketches and assist in making layouts and detailed drawings.

F. **Chief drafter** is a worker who oversees activities of drafting workers engaged in the preparation of sketches, detailed drawings, or finished plans. This individual is a supervisor who assigns work, determines work procedures, keeps records, and trains new workers.

G. **Design checkers** examine revised production drawings to determine accuracy of changes. They must check the dimensions to ensure that the figures are accurate and that the layout of the drawing is correct. Design checkers must return erroneous drawings to the drafter for corrections.

H. **Civil drafters** draw detailed construction drawings, topographical profiles, and related maps and specification sheets used in the planning and construction of highways, river and harbor improvements, flood control, drainage, and other civil engineering projects. These workers make detailed drawings of structures and installations, such as roads, culverts, fresh-water supply and sewage disposal systems, dikes, wharfs, and breakwaters.

I. **Marine drafters** specialize in making drawings of structural and mechanical features of docks, ships, and other marine structures and equipment. These drafters must often work from general design drawings and notes made by marine architects and engineers.

J. **Electronic drafters** draft wiring diagrams, schematics, and layout drawings used in the manufacture, assembly, installation, and repair of electronic equipment, such as television cameras, radio transmitters and receivers, audio amplifiers, printed circuit boards, computers, and radiation detectors. These drafters may work with electrical engineers to develop design sketches for electronic circuitry and equipment.

K. **Mechanical drafters** specialize in drafting detailed working drawings of machinery and mechanical devices, indicating dimensions and tolerances, fasteners and joining requirements, and other engineering data. These workers make multiview drawings needed for the manufacture and repair of mechanical devices.

L. **Industrial designers** design products to be manufactured, packaging, and trademarks. These designers work closely with sales and marketing employees to obtain design information that can be turned into product development. These designers sketch designs of products, such as furniture, lamps, motor vehicles, household appliances, and a host of other manufactured goods. These workers must also coordinate the drafting of sketches into working drawings and specification sheets for personnel.

M. **Architects** plan and design private residences, office buildings, theaters, public buildings, factories, and other structures. An architect prepares sketches of proposed projects for clients, writes specifications, prepares detailed drawings, and originates other contract documents for building contractors.

N. **Drafting checkers** examine drawings to correct errors in computing and recording dimensions and specifications. These workers compare figures on production layout with drawings, examining angles, tolerances, bend allowances, and dimensions for accuracy. Drafting checkers must have a knowledge of drafting and methods of manufacture so they can determine the suitability of designs, materials, tooling, and fabrication sequences. These individuals must work closely with design personnel to resolve design problems.

MATERIALS FOR STUDENTS

- Vocabulary worksheet
- Newspapers (want ads)
- Brochures on drafting careers
- Magazines, pamphlets, booklets
- Poster board, glue, markers, scissors
- Filmstrips on careers in drafting

SUGGESTED STUDENT ACTIVITIES

1. Students should select one occupation in drafting and conduct research to find out more about it. They should use as many resources as they can to obtain sufficient information. These resources may include libraries, businesses, or community personnel. A written report of their findings should be supplemented by an oral report to other class members.
2. Students should invite the vocational counselor to visit their class to discuss the importance of preparing for work, obtaining employment, work responsibilities, and training for advancement.
3. Have students organize their class into a drafting department. They should have positions for a chief drafter, checker, and detailers. If there are enough students in the class, they should perhaps organize two or more departments. Have the drafting department draw accurate building evacuation plans. These plans could be posted in each room of the school building for all occupants to use as they learn the evacuation routes.
4. Have students examine magazines, pamphlets, newspapers, and other publications to find pictures that illustrate work that drafters do. Have the students work in groups and focus upon one theme. The pictures can be arranged on poster board or some other surface to make a unique collage. The themes could reflect new car designs, changes in car designs through several decades, new product designs, advertising detailed drawings, aerospace designs, or any number of others. Students can use their creativity and arrange their collages in many designs that can also represent drafting. Examples might include the shapes of a car, house, city profile, high-rise building, television, or a landscape.
5. Have students identify individuals in the community who work in drafting occupations. Help students select one or two individuals they would like to invite for a class visit. To avoid communication problems, the teacher should contact the individual and extend an invitation on behalf of the class.

   One or two students should act as the visitor's hosts during the visit. These students should explain what they are doing and studying about in class. They should ask the visitor to explain to the class what they can expect to find as drafters in industry. Class members should develop a list of questions they would like to ask the visitor prior to his or her visit.

Vocabulary Worksheet

Directions: Briefly describe what all of the following workers do in their jobs:

1. marine architect
2. detailer
3. technical illustrator
4. landscape architect
5. tool designer
6. chief drafter
7. design checker
8. civil drafter
9. marine drafter
10. electronic drafter
11. mechanical drafter
12. industrial designer
13. architect
14. drafting checker

TEST

Unit 7: Occupational Information About Drafting Careers

Directions: Read each statement carefully. Select the one word or phrase that correctly answers or completes the statement, and write the appropriate letter in the blank.

Example: _C_ 21. The class you are now attending is—

A. American Government
B. Language Arts
C. Industrial Arts
D. General Science

___ 1. Workers who make detailed drawings of parts of machines and structures from rough or general design drawings are—

A. deleters
B. detailers
C. drawers
D. defenders

___ 2. Individuals who plan and design the development of land areas for parks, airports, schools, and residential areas are—

A. residential architects
B. recreational architects
C. landscape architects
D. landstake architects

___ 3. Individuals who lay out and draw illustrations for reproduction in reference books, brochures, and technical manuals are—

A. technical illustrators
B. technical illuminators
C. industrial designers
D. photo designers

___ 4. Workers who use a variety of tools and materials to construct scale models according to specifications are—

A. civil drafters
B. mechanical drafters
C. mold makers
D. model makers

___ 5. The worker who oversees activities of drafting workers engaged in the preparation of sketches, detailed drawings, or finished plans is a—

A. civil drafter
B. chief drafter
C. current drafter
D. craft drafter

___ 6. Workers who specialize in making drawings of structural and mechanical features of docks, ships, and other ship's equipment are—

A. merchant drafters
B. marine drafters
C. Maine drafters
D. market drafters

___ 7. Individuals who specialize in drafting detailed working drawings of machinery and mechanical devices are—

A. mechanical drafters
B. mechanical engineers
C. mechanism drafters
D. mechanic drafters

___ 8. Individuals who draw detailed construction drawings for civil engineering projects are—

A. civil engineers
B. civil contractors
C. civil drafters
D. civil designers

___ 9. Individuals who draft wiring diagrams, schematics, and layouts for the manufacture, assembly, and repair of electronic equipment are—

A. diagram drafters
B. electronic drafters
C. electronic diagrammers
D. manufacturing drafters

___ 10. Individuals who design products to be manufactured, packaging, and trademarks are—

A. manufacturing designers
B. advertising designers
C. production designers
D. industrial designers

SOME DRAFTING OCCUPATIONS

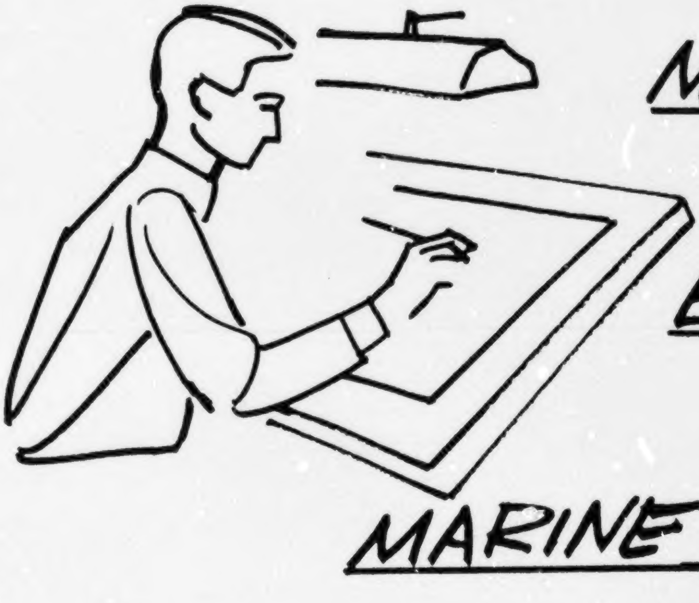
CHIEF DRAFTER

DESIGN CHECKER

DETAILER

TECHNICAL ILLUSTRATOR

CIVIL DRAFTER



MECHANICAL DRAFTER

ELECTRONIC DRAFTER

MARINE DRAFTER

OCCUPATIONS WHICH USE DRAFTING SKILLS AND KNOWLEDGE

INDUSTRIAL DESIGNERS

TOOL DESIGNERS

LANDSCAPE ARCHITECTS

MARINE ARCHITECTS

ARCHITECTS